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Sir,

I, Toshimasa SUZUKI, hereby declare that I am conversant with both English and Japanese languages, and certify to best of my knowledge and belief that the attached is a true and faithful translations made by me of Japanese Application No. 2002-089069 filed on March 27, 2002 on which the right of priority under the International Convention are all claimed for the above-identified application.

Toshimasa SUZUKI

Date: October 1, 2007

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Japanese Government

This is to certify that the annexed is a true copy of the following application as filed with this Office.

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[Title of the Invention] TRAFFIC INFORMATION PROVISION SYSTEM, TRAFFIC INFORMATION PROVISION APPARATUS, AND TRAFFIC INFORMATION GENERATION METHOD

[Claims]

[Claim 1]

A traffic information provision system comprising:

a traffic information provision apparatus for providing a state quantity of traffic information changing along a road as a function of distance from a reference node of a shape vector representing the road; and

a traffic information utilization apparatus for reproducing the traffic information on the road from the function.

[Claim 2]

The traffic information provision system according to Claim 1, wherein the traffic information provision apparatus provides data representing the shape vector together with the traffic information and the traffic information utilization apparatus identifies the target road of the traffic information from the data representing the shape vector.

[Claim 3]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position resolution of the traffic information, quantizing the state quantity at each sampling point in accordance with the traffic representation resolution representing the number of available states of the traffic information, encoding the obtained value and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded value to reproduce the traffic information on the road.

[Claim 4]

The traffic information provision system according to Claim 3, wherein the traffic information provision apparatus performs sampling equidistantly in the direction of distance of the shape vector representing the road.

[Claim 5]

The traffic information provision system according to Claim 3, wherein the traffic information provision apparatus performs sampling in the positions of component points of the shape vector or at an arbitrary point on the link between the component points.

[Claim 6]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, quantizing the state quantity at each sampling point, encoding the obtained value and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded value to reproduce the prediction information of the traffic information on the road.

[Claim 7]

The traffic information provision system according to Claim 3, wherein the traffic information provision apparatus dynamically modifies at least one of the position resolution and traffic representation resolution in accordance with the transmit data volume of the traffic information to be provided.

[Claim 8]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of traffic information or prediction information changing along a road in the direction of distance of the shape vector representing the road, converting the state quantity at each sampling point to a value having statistical deviation, encoding the obtained value and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded value to reproduce the traffic information on the road.

[Claim 9]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of traffic information or prediction information changing along a road in the direction of distance of the shape vector representing the road, quantizing the state quantity at each sampling point, converting the state quantity at each sampling point to a value having statistical deviation, encoding the obtained value and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded value to reproduce prediction information of the traffic information on the road.

[Claim 10]

The traffic information provision system according to Claim 8 or 9, wherein the traffic information provision apparatus obtains the difference from the value in an adjacent quantization-unit so as to convert the value in the target quantization-unit to a value having statistical deviation.

[Claim 11]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, representing the state quantity at each sampling point by a difference value from a state quantity at the sampling point in an adjacent time zone, quantizing the difference value, encoding the quantized value and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded value to reproduce the prediction information of the traffic information on the road.

[Claim 12]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of traffic information or prediction information changing along a road in the direction of distance of the shape vector representing the road, transforming the state quantity at each sampling point to a frequency component, encoding the coefficient value of each frequency and providing the

encoded value; and

a traffic information utilization apparatus for decoding the encoded coefficient value to reproduce the traffic information on the road.

[Claim 13]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, transforming the state quantity at each sampling point to a frequency component, encoding the coefficient value of each frequency and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded value to reproduce the prediction information of the traffic information on the road.

[Claim 14]

A traffic information provision system comprising:

a traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, representing the state quantity at each sampling point by a difference value from a state quantity at the sampling point in an adjacent time zone, transforming the difference value to a frequency component, encoding the coefficient value of each frequency and providing the encoded value; and

a traffic information utilization apparatus for decoding the encoded coefficient value to reproduce the prediction information of traffic information on the road.

[Claim 15]

The traffic information provision system according to any one of Claims 12 to 14, wherein the traffic information provision apparatus quantizes the coefficient value of each frequency so that the coefficient value of a high frequency will show statistical deviation and performs variable length encoding on the obtained value.

[Claim 16]

The traffic information provision system according to any one of Claims 12 to 14, wherein the traffic information provision apparatus encodes the coefficient value of each frequency with the coefficient value of a high frequency being deleted.

[Claim 17]

The traffic information provision system according to any one of Claims 12 to 16, wherein the traffic information provision apparatus dynamically modifies the position resolution corresponding to the interval between the sampling points in accordance with the transmit data volume of the traffic information to be provided.

[Claim 18]

The traffic information provision system according to Claim 15, wherein the traffic information provision apparatus dynamically modifies the traffic representation resolution corresponding to the coarseness of the quantization in accordance with the transmit data volume of the traffic information to be provided.

[Claim 19]

The traffic information provision system according to Claim 16, wherein the traffic

information provision apparatus dynamically modifies the number of coefficient values of the high frequency to be deleted in accordance with the transmit data volume of the traffic information to be provided.

[Claim 20]

The traffic information provision system according to Claim 7, 17, or 18, wherein the traffic information provision apparatus modifies the position resolution or traffic representation resolution of the traffic information in accordance with the importance of the traffic information or target road.

[Claim 21]

The traffic information provision system according to Claim 7, 17, or 18, wherein the traffic information provision apparatus modifies the position resolution or traffic representation resolution of the traffic information in accordance with the distance from a point on the target road of traffic information where information is provided.

[Claim 22]

The traffic information provision system according to a Claim 7, 17, or 18, wherein the traffic information provision apparatus modifies the position resolution or traffic representation resolution of traffic information on a road off the recommended path so that the position resolution or traffic representation resolution will be lowered.

[Claim 23]

The traffic information provision system according to any one of Claims 12 to 15, wherein the data obtained by encoding a FFT coefficient of a low frequency component of a plurality of roads prior to the data obtained by encoding the FFT coefficient of a high frequency component.

[Claim 24]

The traffic information provision system according to any one of Claims 12 to 15, wherein the traffic information provision apparatus provides the data obtained by encoding a FFT coefficient of a low frequency component from a first medium and provides the data obtained by encoding the FFT coefficient of a high frequency component from a second medium.

[Claim 25]

The traffic information provision system according to any one of Claims 3 to 24, wherein the traffic information provision apparatus smoothes the state quantity at the sampling point then proceeds to next processing.

[Claim 26]

The traffic information provision system according to any one of Claims 1 to 25, wherein the traffic information provision apparatus provides, when providing traffic information at the current time, difference data from traffic information provided in the past.

[Claim 27]

The traffic information provision system according to any one of Claims 1 to 26, wherein the traffic information provision apparatus provides the traffic information over a wireless channel or wired line.

[Claim 28]

The traffic information provision system according to any one of Claims 1 to 27,

wherein the traffic information provision apparatus records the traffic information onto a recording medium and provides the recording medium.

[Claim 29]

The traffic information provision system according to any one of Claims 1 to 28, wherein the traffic information provision apparatus, in response to a request for the traffic information, provides the traffic information on the requested road or area.

[Claim 30]

The traffic information provision system according to any one of Claims 1 to 29, wherein the state quantity of the traffic information is a travel speed, a travel time or a congestion situation.

[Claim 31]

A traffic information generation apparatus comprising:

a traffic information converter for sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position resolution of the traffic information and quantizing the state quantity at each sampling point by using a quantization table;

an encoder for encoding, by using an encoding table, the data processed by the traffic information converter;

a quantization-unit determination unit for determining an interval corresponding to the position resolution in accordance with the state of collection of traffic information and selecting the quantization table used by the traffic information converter and the encoding table used by the encoder; and

an information transmitter for transmitting the data encoded by the encoder.

[Claim 32]

A traffic information utilization apparatus comprising:

an information receiver for receiving traffic information represented by a function of distance from the reference node of a shape vector indicating the road and the data representing the shape vector; and

a map matching section for performing map matching by using the data representing the shape vector to identify the target road of traffic information.

[Claim 33]

A traffic information generation method comprising the steps of:

sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position resolution of the traffic information;

quantizing the state quantity at each sampling point in accordance with the traffic representation resolution representing the number of available states of the traffic information;

converting the state quantity obtained to a value having statistical deviation; and

encoding the obtained value to generate traffic information.

[Claim 34]

A traffic information generation method comprising the steps of:

sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position

resolution of the traffic information;

transforming the state quantity at each sampling point to a frequency component;

quantizing the coefficient value of each frequency to obtain a value having statistical deviation; and

encoding the post-quantization coefficient value to generate traffic information.

[Claim 35]

A program which causes a computer to perform the steps of:

determining an interval of sampling of traffic information and the coarseness of quantization in accordance with the state of collection of traffic information;

sampling the state quantity of the collected traffic information in the direction of distance of the shape vector representing the road in the intervals;

quantizing the state quantity at each sampling point by using a quantization table corresponding to the coarseness of quantization; and

coding/compressing the quantized value.

[Claim 36]

A program which causes a computer to perform the steps of:

determining an interval of sampling of traffic information and the coarseness of quantization in accordance with the state of collection of traffic information;

sampling the state quantity of the collected traffic information in the direction of distance of the shape vector representing the road in the intervals;

transforming the state quantity at each sampling point to a frequency component so as to obtain a coefficient value of each frequency;

quantizing the coefficient value by using a quantization table corresponding to the coarseness of quantization; and

coding/compressing the quantized value.

[Claim 37]

A recording medium on which are recorded data of traffic information on a state quantity of traffic information changing along a road represented by a function of distance from the reference point of the shape vector representing the road and data string information of the shape vector representing the road.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention is belongs]

The present invention relates to a method for generating traffic information representing traffic congestion and travel time, a system for providing the traffic information, and apparatus constituting the system, and in particular to a method for generating traffic information representing traffic congestion and travel time, a system for providing the traffic information, and apparatus constituting the system which converts traffic information such as traffic congestion and travel time in a new form in order to efficiently provide traffic information full of rich information.

[0002]

[Prior Art]

<Current VICS Traffic Information>

VICS (Vehicle Information and Communication System) which currently provides a car navigation system with a traffic information provision system collects and edits traffic information and transmits traffic congestion information and travel time information representing the time required by way of an FM multiplex broadcast or a beacon.

[0003]

The current VICS information represents the current traffic information as follows: Traffic situation is displayed in three stages, congestion (ordinary road: □ 10 km/h; expressway: □ 20 km/h); heavy traffic (ordinary road: 10-20 km/h; expressway: 20-40 km/h); and light traffic (ordinary road: □20 km/h; expressway: □ 40 km/h).

[0004]

The traffic congestion information representing the traffic congestion is displayed as "VICS link number + state (congestion/heavy traffic/light traffic/unknown)" in case the entire VICS link (position information identifier) is congested uniformly. In case only part of the link is congested, the traffic congestion information representing the traffic congestion is displayed as "VICS link number + congestion head distance (distance from beginning of link) + congestion end (distance from beginning of link) + state (congestion)". In this case, when the congestion starts from the start end of a link, the head congestion distance is displayed as 0xff. In case different traffic situations coexist in a link, each traffic situation is respectively described in accordance with this method.

[0005]

The link travel time information representing the travel time of each link is displayed as "VICS link number + travel time". As prediction information representing the future change trend of traffic situation, an increase/decrease trend graph showing the four states, "increase trend/decrease trend/no change/unknown" is displayed while attached to the current information.

[0006]

<Transmission of road position independent of VICS link number>

VICS traffic information displays traffic information while identifying a road with a link number. The receiving party of this traffic information grasps the traffic situation of the corresponding road on its map based on the link number. The system where the sending

party and receiving party shares link numbers and node numbers to identify a position on the map requires introduction or a change in new link numbers and node numbers each time a road is constructed anew or changed. With this, the data on the digital map from each company needs updating so that the maintenance requires huge social costs.

[0007]

In order to offset these disadvantages, the inventors of the invention proposes, in the Japanese Patent Application No. 11-214068 and the like, a system where a sending party arbitrarily sets a plurality of nodes on a road shape and transmits a "shape data string" representing the node position by a data string and a receiving party uses the shape data string to perform map matching in order to identify a road on a digital map. A system which compresses data by way of Fourier coefficient approximation to delete the data volume of this shape data string is proposed in the Japanese Patent Application No. 2001-20080. A system which applies statistical processing on the data to convert the data into data which concentrates around ±0 and then converts the data to variable length encoded data for data compression is proposed in the Japanese Patent Application No. 2001-134318.

[0008]

The following approach is possible as an approach to correct a shape vector using relative positions for display. In case the positions of nodes included in a shape vector, cumulative errors occur. The cumulative errors tend to accumulate in case the shape vector has a long distance and has a "gentle shape" such as the National Highway 268 and the National Highway 1. In order to prevent this, the shape as a shape vector is extracted so that the shape will be temporarily bent by way of a crossing road as shown in thick lines in Fig. 40 and then returned to the main route. In this practice, a "point which characterizes the shape" such as the intersection or a curve with a large curvature is set as a reference node to cancel the cumulative errors. The receiving party compares the distance between reference nodes shown in dotted lines obtained by decoding the received data with the distance between reference nodes of a shape vector shown in thick lines thus correcting the relative positions. A reference node specified in a position where cumulative errors can be corrected is hereinafter referred to as a "reference node for correction of relative position". With this system, it is possible to transmit a road position without using link numbers or node numbers.

[0009]

[Problem that the Invention is to solve]

However, the currently provided traffic information cannot support a variety of requests for traffic information, that is, traffic information that has been provided in line with general traffic information, information on the areas along the road, and information on the pertinent road.

[0010]

<Problem 1 of the current traffic information>

In the current traffic information, resolution of information representation is too coarse. The congestion information can be displayed in units of 10 meters concerning the position although the number of traffic information representations is only three, traffic congestion, heavy traffic and light traffic. Representation of traffic information concerning the link travel time may be made in units of 10 seconds although the position resolution is only "per link" and

the minute speed distribution in the link cannot be represented.

[0011]

This could present the following problem: As shown in Fig. 41, a person saw the display of the congested section (section where the vehicle speed is 10 km/h or below) and thinking that the time required to get out of the congestion as long as 500 meters will be short, entered the congested area.

It took the person to get out of the congested section of 500 meters as long as 25 minutes because of too many vehicles. Another story is: a person saw the display of "Link A travel time=30 minutes" and assuming that link A takes longer time, selected an alternate route of the target route of traffic information and it took the person 25 minutes to get through. On the link A, only the congested section near the intersection was time-consuming (25 minutes) wile the remaining sections required only five minutes to pass through. Using the road in dotted lines in the target route area displayed on a car navigation system could take only seven minutes to pass through.

[0012]

As shown in Fig. 42, in case a graph where the vertical axis represents the number of states of traffic information which can be represented (traffic information resolution) and the horizontal axis represents the position (or section) resolution is used to arrange the traffic information, the link travel time has a lower position resolution while it has a higher traffic representation resolution. The congestion information has a lower traffic representation resolution while it has a higher position resolution. In the current congestion information and link travel time information, an intermediate representation shown in Fig. 42 by circle is not available.

[0013]

The traffic information in this circle can be collected. In the case of a probe car which collects data from vehicles running on the road, it is possible to collect information at each level in the circle in the center facility (For example, in case a vehicle speed is measured per 300 meters in units of 3 km/h up to 120 km/h, the position resolution is 200 m and the state number resolution is 40). Original information prior to editing collected via an existing sensor is similar traffic information at an intermediate level, although there are variations in the information due to sensor density. Ideally, a traffic information representation method is preferable which can arbitrarily change both the position resolution and traffic information resolution in line with the source data.

[0014]

<Problem 2 of the current traffic information>

In the current traffic information provision system, the position resolution and traffic representation resolution are fixed. In case the data volume is huge, the transmission path capacity is exceeded as shown in Fig. 43(a). In this case, the data in excess of the transmission path capacity is lost and the data is not transmitted to the receiving party, however important the data may be. Ideally, as shown in Fig. 43(b), it is desirable that the data in excess be not lost when the data volume is about to exceed the transmission path capacity and the resolution of data be made "coarse" in ascending order of importance so as to reduce the

overall data volume.

[0015]

As shown in Fig. 44(a), while the transmission path capacity is large enough, the traffic information is represented by a high position resolution and traffic representation resolution. When the information volume has increased near the transmission path capacity, as shown in Fig. 44(b), it is desirable to reduce the position resolution concerning the information on a route whose importance is low, reduce the traffic representation resolution concerning the information on a route distant from the information provision point, or reduce the position resolution and traffic representation resolution concerning the prediction information on far future in order to keep displaying the information on an immediately close route of importance in a high resolution.

[0016]

<Problem 3 of the current traffic information>

The current traffic information representation form is not fit for representation of traffic prediction information. Various approaches of traffic prediction have been developed such as a simulation method. With the future development of traffic information providers, services to provide traffic prediction information are expected to grow. However, the current traffic information provides only the data showing the “increase/decrease trend” as prediction information. An attempt to transmit the prediction information of congestion in the current traffic information representation form results in a proportional increase in the data volume corresponding to the number of prediction time zones. Concerning the congestion state, there are many cases where congestion occurs in a time zone and in the next time zone also. Thus data is transmitted in a duplicated fashion, which is inefficient.

[0017]

<Object of the Invention>

The invention has been accomplished to solve the problems with the related art traffic information and has as an object to provide a method for generating traffic information which can arbitrarily set a position resolution and a traffic representation resolution and change the position resolution and the traffic representation resolution on demand in accordance with the importance of information, and which can flexibly support a “prediction service” expected to occur in future, as well as to provide a system which provides the traffic information, and apparatus constituting the system.

[0018]

[Means for solving the Problem]

Thus, a traffic information provision system according to the invention includes a traffic information provision apparatus for providing a state quantity of traffic information changing along a road as a function of distance from a reference node of a shape vector representing the road; and a traffic information utilization apparatus for reproducing the traffic information on the road from the function.

[0019]

In addition, the traffic information provision system according to the invention includes: a traffic information provision apparatus for sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in

intervals corresponding to the position resolution of the traffic information, quantizing the state quantity at each sampling point in accordance with the traffic representation resolution representing the number of available states of the traffic information, encoding the obtained value and providing the encoded value; and a traffic information utilization apparatus for decoding the encoded value to reproduce the traffic information on the road.

[0020]

The traffic information provision system according to the invention includes: traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, quantizing the state quantity at each sampling point, encoding the obtained value and providing the encoded value; and traffic information utilization apparatus for decoding the encoded value to reproduce the prediction information of the traffic information on the road.

[0021]

The traffic information provision system according to the invention includes: traffic information provision apparatus for sampling a state quantity of traffic information or prediction information changing along a road in the direction of distance of the shape vector representing the road, converting the state quantity at each sampling point to a value having statistical deviation, encoding the obtained value and providing the encoded value; and traffic information utilization apparatus for decoding the encoded value to reproduce the traffic information or prediction information on the road.

[0022]

The traffic information provision system according to the invention includes: traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, representing the state quantity at each sampling point by a difference value from a state quantity at the sampling point in an adjacent time zone, quantizing the difference value, encoding the quantized value and providing the encoded value; and traffic information utilization apparatus for decoding the encoded value to reproduce the prediction information of the traffic information on the road.

[0023]

The traffic information provision system according to the invention includes: traffic information provision apparatus for sampling a state quantity of traffic information or prediction information changing along a road in the direction of distance of the shape vector representing the road, transforming the state quantity at each sampling point to a frequency component, encoding the coefficient value of each frequency and providing the encoded value; and traffic information utilization apparatus for decoding the encoded coefficient value to reproduce the traffic information or prediction information on the road.

[0024]

The traffic information provision system according to the invention includes: traffic information provision apparatus for sampling a state quantity of prediction information of traffic information changing along a road in the direction of distance of the shape vector representing the road, representing the state quantity at each sampling point by a difference value from a state quantity at the sampling point in an adjacent time zone, transforming the difference value

to a frequency component, encoding the coefficient value of each frequency and providing the encoded value; and traffic information utilization apparatus for decoding the encoded coefficient value to reproduce the prediction information of traffic information on the road.

[0025]

Traffic information generation apparatus according to the invention includes: a traffic information converter for sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position resolution of the traffic information and quantizing the state quantity at each sampling point by using a quantization table; an encoder for encoding, by using an encoding table, the data processed by the traffic information converter; a quantization-unit determination unit for determining an interval corresponding to the position resolution in accordance with the state of collection of traffic information and selecting the quantization table used by the traffic information converter and the encoding table used by the encoder; and an information transmitter for transmitting the data encoded by the encoder.

[0026]

Traffic information utilization apparatus according to the invention includes: an information receiver for receiving traffic information represented by a function of distance from the reference node of a shape vector indicating the road and the data representing the shape vector; and a map matching section for performing map matching by using the data representing the shape vector to identify the target road of traffic information.

[0027]

A traffic information generation method according to the invention includes the steps of: sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position resolution of the traffic information; quantizing the state quantity at each sampling point in accordance with the traffic representation resolution representing the number of available states of the traffic information; converting the state quantity obtained to a value having statistical deviation; and encoding the obtained value to generate traffic information.

[0028]

The traffic information generation method according to the invention includes the steps of: sampling a state quantity of traffic information changing along a road in the direction of distance of the shape vector representing the road in intervals corresponding to the position resolution of the traffic information; transforming the state quantity at each sampling point to a frequency component; quantizing the coefficient value of each frequency to obtain a value having statistical deviation; and encoding the post-quantization coefficient value to generate traffic information.

[0029]

A program according to the invention causes a computer to perform the steps of: determining an interval of sampling of traffic information and the coarseness of quantization in accordance with the state of collection of traffic information; sampling the state quantity of the collected traffic information in the direction of distance of the shape vector representing the road in the intervals; quantizing the state quantity at each sampling point by using a quantization table corresponding to the coarseness of quantization; and encoding/compressing

the quantized value.

[0030]

The program according to the invention causes a computer to perform the steps of: determining an interval of sampling of traffic information and the coarseness of quantization in accordance with the state of collection of traffic information; sampling the state quantity of the collected traffic information in the direction of distance of the shape vector representing the road in the intervals; transforming the state quantity at each sampling point to a frequency component so as to obtain a coefficient value of each frequency; quantizing the coefficient value by using a quantization table corresponding to the coarseness of quantization; and encoding/compressing the quantized value.

[0031]

On a recording medium for providing traffic information are recorded data of traffic information on a state quantity of traffic information changing along a road represented by a function of distance from the reference point of the shape vector representing the road and data string information of the shape vector representing the road.

[0032]

According to the traffic information provision system of the invention, it is possible to arbitrarily set a position resolution and a traffic representation resolution thus changing the resolution of information representation in accordance with the importance of traffic information. Further, it is possible to flexibly support the “prediction service” of traffic information.

[0033]

[Mode for Carrying Out the Invention]

In the invention, the “travel time information” and the “congestion information” as a “traffic congestion index” are essentially the same in that they are traffic information obtained based on the vehicle travel speed and traffic information changing continuously along a road, although they use different representation forms (number of position resolution and state resolution representations). In the invention, traffic information changing continuously along a road is understood as a function of distance (length) from a reference node defined at the beginning of a shape vector or in the shape vector. A party which provides the traffic information transmits this function or coefficient of the function to a receiving party. The receiving party reproduces the function from the received information thus reproducing the traffic information changing continuously along the road. By doing so, it is possible to uniformly represent and transmit “travel time information” and “congestion information” by using the same concept and same rules. To represent traffic information by a function, an embodiment of the invention performs re-sampling equidistantly between the reference nodes of a shape vector (the road) for which traffic information is provided and samples data in the direction of distance, obtains the value of a travel speed (or a travel time or congestion information) at each sampling point and represents the traffic information by a data string of this value.

[0034]

(First embodiment)

<Traffic information generation method>

A first embodiment of the invention pertains to a case where a state quantity of traffic

information (congestion information and travel time information) at each sampling point is quantized and variable length encoded to generate traffic information.

[0035]

Referring to Fig. 2, a schematic view of a graph showing the traffic information (congestion information and travel time information), with the horizontal axis representing a distance on the shape vector and the vertical axis a time axis. One square of the horizontal axis represents the unit block length of a quantization-unit (quantization-unit in the direction of distance) set by way of sampling while one square of the vertical axis a constant time interval. In each square of this graph is recorded travel speed information corresponding to the distance from the reference node (start point) and the time elapsed from the current time. A reference node for correction of relative position is set to the reference node on the horizontal axis. In Fig. 2, for the convenience, the graph is segmented into the areas: (a) area where the travel speed is ranked in congestion (ordinary road: □ 10 km/h; expressway: □ 20 km/h); (b) area ranked in heavy traffic (ordinary road: 10-20 km/h; expressway: 20-40 km/h); (c) area ranked in light traffic (ordinary road: □ 20 km/h; expressway: □ 40 km/h); and (d) unknown area.

[0036]

In case traffic information is displayed as shown in Fig. 2, the actual traffic obtained from past observation of traffic can be represented by one of the following correlation laws indicating the correlation between squares. Correlation Law A: Correlation between adjacent squares in the direction of distance is high (when traffic is congested at a point, traffic is also congested at an adjacent point) ((1) in Fig. 2). Correlation Law B: Correlation between adjacent squares in the direction of time is high (when traffic is congested, a time, traffic is also congested at a preceding or subsequent time) ((2) in Fig. 2). Correlation Law C: Correlation concerning a change in the direction of time is high (when traffic becomes congested, traffic generally becomes congested on all roads at the same time) ((3) in Fig. 2). Correlation Law D: the extension speed of congestion beginning with a bottleneck intersection (intersection as a start point of congestion, such as “Ayase Bus Stop”) and the inverse propagation speed on an expressway are substantially constant. For variable length encoding of traffic information, use of such laws can reduce the overall data volume.

[0037]

Figs. 1(a) to 1(d) show the processing where statistical processing is made on traffic information data (state quantity) to convert the data to data which concentrates around ±0 in variable length encoding of traffic information at the current time. As shown in Fig. 1(a), a shape vector having a distance of X m is equidistantly segmented by a unit block length (Example: 50-500 m) to perform sampling. As shown in Fig. 1(b), the average speed of a vehicle passing through each sampling point is obtained. In Fig. 1(b), the value of the obtained speed is shown in a square representing the quantization-unit set through sampling. In this case, the average travel time of congestion rank of a vehicle passing through each sampling interval may be obtained instead of the average speed.

[0038]

Next, the speed value is converted to a quantized volume by using the traffic information quantization table shown in Fig. 3. In the traffic information quantization table, in response to the user’s request for detailed information of congestion, setting is made so that

the quantized volume will increase in steps of 1 km/h in case the speed is less than 10 km/h, 2 km/h in case the speed is within the range of 10 to 19 km/h, 2 km/h in case the speed is within the range of 10 to 19 km/h, 5 km/h in case the speed is within the range of 20 to 49 km/h, and 10 km/h in case the speed is equal to or more than 50 km/h. Quantized values obtained using the traffic information quantization table are shown in Fig. 1(c).

[0039]

Next, the quantized volume is represented by a difference from the statistical prediction value. In this example, difference between the quantized speed Vn in the target quantization-unit and a quantized speed Vn-1 in the upstream quantization-unit or statistical prediction value S is calculated by using (Vn – Vn - 1). The calculation result is shown in Fig. 1(d).

[0040]

In case the quantized value is represented by a difference from the statistical prediction value, frequency of appearance of values around ±0 becomes higher from Correlation Law A (traffic situation is similar between adjacent quantization-units). Variable length encoding is performed on the data thus processed. The variable length encoding is the same as that described in the Japanese Patent Application No. 2001-134318.

[0041]

Past traffic information is analyzed and an encoding table for encoding the statistical prediction difference value of traffic information is created. By using the encoding table, the value in Fig. 1(d) is encoded. For example, +2 is encoded to "1111000" while -2 is encoded to "1111001". In case 0 continues, such as 00000, the data is encoded to "100".

[0042]

In the encoding table, special codes are set: a block length change code for indicating the change in unit block length from a point in case the unit block length has been switched from the point; a traffic information quantization table change code for indicating the change in the traffic information quantization table from a point in case the traffic information quantization table (Fig. 3) has been switched from the point; and a reference-node-related point identification code for indicating a reference node.

[0043]

In this way, by quantizing the traffic information and converting the quantized value to a statistical prediction value and increasing the frequency of values appearing around ±0, the effect of data compression through variable length encoding (Huffman/arithmetic code/Shannon-Fano, etc.) or run-length compression (run-length encoding) is enhanced. In particular, in case the congestion information is displayed in ranks of four stages as in the related art, the statistical prediction difference value in most quantization-units is 0 so that the effect of run-length compression is very high. For the travel time information also, all extralegal speeds are set to a single quantized value in the traffic information quantization table (Fig. 3) to enhance the effect of run-length compression.

[0044]

It is possible to change the position resolution and traffic representation resolution of traffic information by changing the unit block length for sampling of shape vector or by switching between traffic information quantization tables. It is readily possible to appropriately

control the traffic information resolution and position resolution of traffic information in accordance with the volume of traffic information, transmission path capacity of an information provision medium, and the requested accuracy.

[0045]

While the quantized speed Vn-1 in the upstream quantization-unit is used as a statistical prediction value, the statistical prediction value may be another value. For example, in case the weighted average of speeds up to third the quantization-unit upstream is used as a statistical prediction value S, the statistical prediction value S is calculated by using the following formula: Statistical prediction value S = aVn-1 + bVn-2 + cVn-3 (where a + b + c = 1)

[0046]

<System configuration>

Fig. 5 shows a broadcast-type traffic information provision system which generates and provides traffic information. The system includes: traffic information measurement apparatus 10 for measuring traffic information by using a sensor A (ultrasonic vehicle sensor) 21, a sensor B (AVI sensor) 22 and a sensor C (probe car) 23; an encoding table creating unit 50 for creating an encoding table used for encoding of traffic information; a traffic information transmitter 30 for encoding and transmitting traffic information and information in the target section; and receiving party apparatus for receiving transmitted information.

[0047]

The traffic information measurement apparatus 10 includes a sensor processor A 11, a sensor processor B 12 and a sensor processor B 13 for processing data acquired from each sensor 21, 22, 23 and a traffic information calculator 14 for generating traffic information by using the data processed in the sensor processors 11, 12, 13 and outputting the traffic information data and data indicating the target section.

[0048]

The encoding table creating unit 50 includes a plural types of traffic information quantization tables 53 used for quantization of traffic information and a distance quantization-unit parameter table 54 defining plural types of sampling point intervals (unit block length). The encoding table calculating unit 51 for creating an encoding table classifies the past traffic situations obtained by the traffic information measurement apparatus 10 into patterns and creates various encoding tables 52 for all combinations of a traffic information quantization table 53 and a sampling point interval.

[0049]

The traffic information transmitter 30 includes: a traffic information collector 31 for collecting traffic information from the traffic information measurement apparatus 10; a quantization-unit determination unit 32 for determining the traffic situation based on the collected traffic information, determining the sampling point interval (unit block length of quantization-unit), and determining the quantization table and encoding table to be used; a traffic information converter 33 for quantizing traffic information and converting traffic information to a statistical prediction difference value by using the sampling point interval and the traffic information quantization table 53 determined by the quantization-unit determination unit 32, and converting shape vector in the target section to a statistical prediction difference value; an encoder 34 for encoding traffic information by using the encoding table 52

determined by the quantization-unit determination unit 32 and performing cording of the shape vector in the target section; an information transmitter 35 for transmitting the encoded traffic information data and shape vector data; and a digital map database 36 referenced by the a traffic information converter 33.

[0050]

The receiving party apparatus 60 includes: an information receiver 61 for receiving the information provided by the traffic information transmitter 30; a decoder for decoding the received information to reproduce the traffic information and shape vector; a map matching/section determination unit 63 for determining the target section of traffic information; a traffic information reflecting unit for reflecting the received information in the data of the target section in a link cost table 66; a local vehicle position determination unit 68 for determining the position of a local vehicle by using a GPS antenna 69 and a gyroscope 70; an information utilization unit for utilizing the link cost table 66 for a route search from the local vehicle position to the destination; and guidance apparatus 71 for providing audio guidance based on the route search result.

[0051]

Features such as those implemented by the encoding table calculating unit 51 in the encoding table creating unit 50 and the quantization-unit determination unit 32, the traffic information converter 33, the encoder 34, and the information transmitter 35 in the encoding table creating unit 30 can be implemented by causing a computer to perform programmed processing. Features such as those implemented by the decoder 62, the map matching/section determination unit 63, the traffic information reflecting unit 64, the Local vehicle position determination unit 68 and the information utilization unit 67 can be implemented by causing a computer to perform programmed processing.

[0052]

Figs. 7(a) and 7(b) show a data structure of map data (a) indicating the target section of traffic information and traffic information data (b) output by the traffic information measurement apparatus 10. The flowchart of Fig. 6 shows the operation of each part of the system. The encoding table calculating unit 51 of the encoding table creating unit 50 analyzes the past traffic information transmitted from the traffic information measurement apparatus 10 to summarize the traffic information of the traffic situation of pattern L (step 1), set the quantization-unit in the direction of distance (sampling point interval) M (step 2), and set the traffic information quantization table N (step 3). Then, the encoding table calculating unit 51 calculates the statistical prediction difference values of the traffic information on the basis of the formula for calculating the statistical prediction value (step 4). Next, the encoding table calculating unit 51 calculates the distribution of statistical prediction difference values (step 5) and calculates the distribution of run lengths (continuous distribution of same value) (step 6). The encoding table calculating unit 51 creates an encoding table based on the distribution of statistical prediction difference values and run lengths (step 7) to complete the encoding table for case L-M-N (step 8). The encoding table calculating unit 51 repeats the processing until all cases of L-M-N are complete (step 9). In this way, a large number of encoding tables supporting various traffic situation patterns and resolutions of information representation are previously created and maintained.

[0053]

Next, the traffic information transmitter 30 collects traffic information and determines a traffic information provision section (step 10). Determining that one traffic information provision section V is to be addressed (step 11), the traffic information transmitter 30 generates a shape vector around the traffic information provision section V and sets a reference node (step 12), then performs reversible or irreversible compression of the shape vector (step 13). The irreversible encoding/compression method is detailed in the Japanese Patent Application No. 2001-134318.

[0054]

The quantization-unit determination unit 32 determines the traffic situation and determines the sampling interval (unit block length of quantization-unit) and the quantization level (step 14). This processing is detailed later.

[0055]

The traffic information converter 33 performs sampling in the direction of distance from the reference node of the shape vector by using the determined unit block length and splits the traffic information provision section (step 15), and calculates the traffic information per quantization-unit (step 16). The traffic information converter 33 then performs preprocessing in order to enhance the compression effect of encoding (step 17). The preprocessing is detailed later. The traffic information converter 33 performs quantization of traffic information by using the traffic information quantization table 53 determined by the quantization-unit determination unit 32 based on the quantization level (step 18) and converts the quantized traffic information to a statistical prediction difference value (step 19).

[0056]

Next, the encoder 34 executes variable length encoding/compression of quantized traffic information by using the encoding table 52 determined by the quantization-unit determination unit 32 (step 20). The encoder 34 then corrects the unit block length by using the reference node for correction of relative position (step 21). This processing is executed for all traffic information provision sections (step 23). The information transmitter 35 converts the encoded data to transmit data (step 24) and transmits the data together with the encoding table (step 25).

[0057]

Figs. 8(a) and 8(b) show examples of data structure of shape data string information (a) and traffic information (b). From the traffic information transmitter 30, a shape vector encoding table, a traffic information quantization table (Fig. 3) and an encoding table of statistical prediction difference values of traffic information (Fig. 4) are transmitted simultaneously or over an alternate route, on top of the above information. While the traffic information (Fig. 8(b)), a data item of "Number of quantized unit sections" is provided, an EOD (End of Data) code indicating the end of data in the encoding table may be set as a special code so as to indicate the end of a quantization-unit in the direction of distance in the encoded traffic information data string, instead of the data item.

[0058]

As shown in the flowchart of Fig. 6, when the information receiver 61 receives the data (step 30), the receiving party apparatus 60 determines that one traffic information provision

section V is to be addressed (step 31). The decoder 62 decodes the shape vector. The map matching/section determination unit 63 performs map matching on its digital map database 65 to identify the target road section (step 32) and corrects the unit block length by using the reference node for correction of relative position (step 33).

[0059]

The decoder 62 decodes traffic information referring to the encoding table (step 34). The traffic information reflecting unit 64 reflect the decoded travel time in the link cost of the local system (step 35). This processing is executed for all traffic information provision sections (steps 36, 37). The Information utilization unit 67 utilizes the provided travel time to execute required time display and route guidance (step 38).

[0060]

<Method for determining the quantization-unit>

The procedure where the quantization-unit determination unit 32 of the traffic information transmitter 30 determines the traffic situation to determine the sampling point interval (unit block length of quantization-unit) and the quantization level (step 14) in the processing in Fig. 6 is described below. The quantization-unit determination unit 32 determines the traffic situation and determines the resolution of information representation so that the transmit data volume of traffic information will not exceed the transmission path capacity of the traffic information transmitter 30. The resolution of information representation has position resolution and traffic representation resolution as its factors. The position resolution is determined by the interval of sampling points (unit block length of quantization-unit) in sampling. The traffic representation resolution is determined by the quantization level indicating the coarseness of quantization which is determined by the selected quantization table. The quantization-unit determination unit 32 determines the sampling interval and the quantization table in the course of determination of information representation resolution.

[0061]

In case the sampling interval is smaller, the traffic information is more detailed but the data volume is larger. In case the sampling interval is larger, the traffic information is less detailed but the data volume is smaller. Similarly, in case a quantization table is used to quantize the state quantity of traffic information, the traffic information can be represented in detail but the data amount is large. Use of a coarse quantization table results in less detailed traffic information and a smaller data volume.

[0062]

The quantization-unit determination unit 32 predicts the transmit data volume of traffic information from the current traffic situation and adjusts the resolution of information representation so that the transmit data volume will not exceed the transmission path capacity. In this practice, the quantization-unit determination unit 32 considers the importance of traffic information of each route to determine the sampling interval and quantization table representing the traffic information of each route, and determines the encoding table corresponding to the sampling interval and quantization table as well as the traffic situation pattern.

[0063]

The flowchart of Fig. 9 shows an example of processing by the quantization-unit

determination unit 32. The quantization-unit determination unit 32 determines the target data size so that the transmit data volume will not exceed the transmission path capacity of the traffic information transmitter 30 (step 40). The quantization-unit determination unit 32 calculates the approximate post-coding data size of the original information transmitted from the traffic information measurement apparatus 10 in this cycle (Figs. 7(a) and 7(b)) based on the ratio of the data size of the original information transmitted from the traffic information measurement apparatus 10 in the last cycle (Fig. 7(a)) to the data size of transmit data sent which is obtained by encoding the original data (Figs. 8(a) and 8(b)), and accordingly determines the expansion ratio (or reduction ratio) of the target data (step 41).

[0064]

The quantization-unit determination unit 32 determines the traffic situation pattern L (step 42). The quantization-unit determination unit 32 extracts one traffic information provision section W around the transmission point where the traffic information transmitter 30 is transmitting traffic information (steps 43, 44) and determines the importance of information of the traffic information provision section W from the attribute of a map data link of the traffic information provision section W (such as road type/road number/number of intersections per unit length), road structure such as road width, traffic volume, traffic situation (such as congestion), and the distance between the barycenter position of the traffic information provision section W and the transmission point (step 45).

[0065]

The quantization-unit determination unit 32 obtains an increment/decrement value in the column where the importance of information obtained in step 45 crosses the expansion ratio (or reduction ratio) of target data obtained in step 41 from the table in Fig. 10(a), and adds the increment/decrement value to the default value of the information representation rank (quantization-unit rank) corresponding to the importance of information to calculate the quantization-unit rank. Then, the quantization-unit determination unit 32 determines the sampling point interval (quantization-unit in the direction of distance) MW and the traffic information quantization table NW corresponding to the quantization-unit rank from the table in Fig. 10(b) (step 46). The quantization-unit determination unit 32 uses the encoding table of L-MW-NW for encoding of traffic information of the traffic information provision section W. This processing is performed for all traffic information provision sections around the transmission point (steps 47, 48).

[0066]

With this processing, it is possible to dynamically change the sampling point interval and quantization level in accordance with the transmit data volume and the importance of information in the traffic information provision section. In the case of an FM multiplex broadcast, for example from the Tokyo Broadcast Station, information is provided so that the information on the Tokyo metropolitan area will be more detailed and information on the adjacent prefectures will be less detailed.

For information provision by way of a beacon, information is provided so that information around a point where a beacon is installed will be more detailed and information will be less detailed with distance from the point. In this way, it is possible to change the sampling point

interval and the quantization level in accordance with the distance from the information provision point or information provision area.

[0067]

The flowchart of Fig. 11 shows a method whereby, in case a recommended path is calculated in the center and the recommended path and the traffic information of adjacent areas are provided, the resolution of the traffic information of the recommended path becomes more detailed and the resolution of the adjacent areas off the recommended path becomes less detailed with distance from the recommended path. The quantization-unit determination unit 32 collects the information on the recommended path (step 50), determines the traffic situation pattern L (step 51) and determines the quantization-unit in the direction of distance M0 and the traffic information quantization table N0 corresponding to rank 1 from the table in Fig. 10(b) (step 52).

[0068]

The quantization-unit determination unit 32 extracts one traffic information provision section W around the recommended path (steps 53 and 54), calculates the barycenter of the traffic information provision section W, and calculates the distance of the perpendicular from the barycenter to the recommended path (step 55). From the distance of the perpendicular, the quantization-unit determination unit 32 determines the quantization-unit in the direction of distance MW in the traffic information provision section and the traffic information quantization table NW (step 56). This processing is performed for all traffic information provision sections around the recommended path (steps 57 and 58). In this way, the quantization-unit determination unit 32 determines the resolution of information representation in accordance with the importance of traffic information provided.

[0069]

<Preprocessing>

The traffic information converter 33 performs preprocessing of smoothing the data of traffic information prior to quantization of traffic information so as to enhance the compression effect. The flowchart of Fig. 12 shows the preprocessing procedure of obtaining the weighted average of data in the adjacent section N to smooth the data. The traffic information converter 33 focuses on the section p (steps 60 and 61). Then the traffic information converter 33 collects the traffic information Tp of each of the total N sections starting with the section p and those immediately before and after p, in order from the first section of the quantization-unit in the direction of distance (step 62). The traffic information converter 33 then replaces the traffic information Tp in the section p with the weighted average of the traffic information of the N sections calculated using the following formula (step 63):

$$Tp=(\Sigma a_i \times Ti)/N \quad \text{where } \Sigma a_i=1$$

This processing is performed for all quantization-units in the direction of distance (step 64).

[0070]

The above preprocessing helps represent the overall trend of traffic situation changing microscopically. With this preprocessing, the statistical prediction difference value after quantization concentrates around 0 thus enhancing the compression effect of encoding. In case congestion information is displayed, a microscopic change in the traffic information of some sections may be neglected without imposing inconvenience on the user of information.

[0071]

As shown in Fig. 13(a), in case data of some sections are larger than that of the preceding and subsequent sections and the difference exceeds a prespecified value, the sections are called a peak.
As shown in Fig. 13(b), in case data of some sections are smaller than that of the preceding and subsequent sections and the difference exceeds a prespecified value, the sections are called a dip.
On the congestion information display, information of a short peak or dip section can be neglected.

[0072]

The flowchart of Fig. 14 shows the preprocessing method used in this case. The traffic information converter 33 focuses on the section p (steps 70, 71). Then the traffic information converter 33 collects the traffic information Tp of each of the total N sections starting with the section p, in order from the first section of the quantization-unit in the direction of distance (step 71). The traffic information converter 33 then searches for peaks and dips in the section p through section p+N (step 72). When the width of a peak or a dip is below a prespecified value, the traffic information converter 33 replaces the peak or dip with the average value of traffic information of the immediately preceding section and immediately subsequent section (step 73).

[0073]

Search for peaks and dips is performed in the following procedure: 1. Calculate the average value and standard deviation of the traffic information of the sections p through p+N. 2. Calculate the deviation value of the traffic information Tp+I of each section. 3. In case the deviation value is more than or less than a prespecified value, Tp+I is determined as a peak or a dip. With this preprocessing, it is possible to enhance the compression effect of encoding of traffic information thus reducing the transmission data volume.

[0074]

<Variation example>

A case has been described where a fixed value (for example in units of 100 m) is set to the sampling point interval (unit block length of quantization-unit) and sampling is performed in equal intervals (fixed-value intervals) in the direction of distance from the reference node of a shape vector. A case is also allowed where the amount of splitting between the beginning and the end of a shape vector is specified and the distance between the beginning and the end is split in equal intervals to set a quantization-unit in the direction of distance. In this case, the traffic information data (Fig. 8(b)) includes the data of the reference node number at the end, the reference node number at the beginning, and the amount pf splitting from the beginning to the end. Receiving this data, the receiving party calculates the unit block length of the quantization-unit by dividing the distance between the reference node at the beginning and reference node at the end by the amount of splitting.

[0075]

It is possible to use a section between component points such as nodes and interpolation points included in a shape vector as the quantization-unit of traffic information. In this case, the distance between the component points after compression/coding of a shape

vector is used as a section of quantization-unit. The quantization-unit does not have an equal interval although variable length encoding is available by representing a travel time (or a travel speed) by a difference from the traffic information of an adjacent quantization-unit.

[0076]

In case traffic information is generated using the method of the embodiment of the invention, quantization is preferably performed so that quantization will be more minute as the speed becomes lower and coarser as the speed becomes higher, as shown in Fig. 3. The travel time is in inverse proportion to the speed so that a small change may have a great influence at low speeds. To smooth an error assumed after conversion to a travel time, geometric discrete values are preferably used to represent a speed quantization table.

[0077]

(Second embodiment)

<Difference representation of prediction information>

A second embodiment of the invention pertains to generation of prediction information of traffic information. To represent prediction information by difference, two methods are available as schematically shown in Fig. 15. The first method is a method whereby the difference in the direction of distance in the traffic information of the time zone N+1 (a) is calculated (d) and the information on this difference (change point) is encoded. This approach is the same as the encoding of current information described in the second embodiment. The second method is a method whereby the difference between the traffic information of the time zone N+1 (a) and the traffic information of the preceding time zone N (b) is extracted (c), and the difference in the direction of distance is calculated based on the extracted difference for later encoding (e). Which of the first and second methods is more advantageous in terms of reduction of data volume depends.

[0078]

Generally speaking, congestion is headed by a bottleneck intersection (such as Harajuku Intersection and Hatano Bus Stop on Tomei Expressway) and its tail extends or shrinks, and especially in case the time difference of time zones N and N+1 is small, the tail of congestion remains unchanged in most cases. Thus the second method is more advantageous. However, in case two occurrences of congestion have merged into a single occurrence of congestion, or in case both head and tail of congestion changes, the total number of change points is larger in the second method (e) so that the first method (d) proves more advantageous. Selection of either method should be made on a case-by-case basis. The best approach is to select between the first and second method, on a per traffic information provision section basis, depending on the time difference up to the predicted time zone or change in the traffic situation. The first method has been described in the first embodiment. In the second embodiment, generation of traffic information using the second method is described.

[0079]

<Coding of prediction information>

Fig. 16(a) shows the traffic information in the current information in each quantization-unit and prediction information in the next time zone. The traffic information in the current information and prediction information is quantized by using a quantization table (Fig. 16(b)).

Next, the prediction information is represented by the difference from the current information (Fig. 16(c)). In this practice, data increases where the value of prediction information concentrates around ±0 from Correlation Law B. In Fig. 16(c), the value of current information is represented by the difference from the value (assumed as a statistical prediction value) in the adjacent quantization-unit.

[0080]

Next, the prediction information is represented by the difference from the statistical prediction value (Fig. 16(d)). In this practice, many of the statistical prediction difference values of prediction information concentrate around ±0 from Correlation Law C. In the processing in Fig. 16(c), calculating the difference by subtracting the prediction information from the current information obtains the same result. Representation in reverse chronological direction is also possible.

[0081]

The statistical prediction difference value of each of the current information and prediction information is encoded by using an encoding table. As shown in Fig. 17(a), the encoding table for encoding the statistical prediction difference value of the current information is the same as that in the first embodiment (Fig. 4). The encoding table for encoding the statistical prediction difference value of the prediction information is the same as that for the current information except that no special codes are used, as shown in Fig. 17(b).

[0082]

<System configuration>

Fig. 18 shows a broadcast-type traffic information provision system which generates and provides traffic information including prediction information. The traffic information measurement apparatus 10 of this system includes a traffic information/prediction information calculator 15 for generating current information of traffic information by using the data processed by the sensor processors 11, 12, 13, generating prediction information by using the statistical information 16, and outputting these traffic information data and data indicating the target section. The remaining configuration is the same as that in the first embodiment (Fig. 5).

[0083]

The flowchart of Fig. 19 shows the operation of each section of this system. The processing in the encoding table creating unit is different from the processing in the first embodiment (Fig. 6) in that a process of creating an encoding table used for encoding of prediction information (steps 104 through 108) is added. The processing in the traffic information transmitter is different from the processing in the first embodiment (Fig. 6) in that prediction information data is encoded as well as current information. The remaining operation is the same.

[0084]

Figs. 20(a) and 20(b) show a data structure of shape data string information (a) and traffic information (b) transmitted from the traffic information transmitter 30. The shape data string information (a) is the same as that in the first embodiment (Fig. 8(a)). For the traffic information (b), the asterisked data is different from the data in the first embodiment (Fig. 8(b)). An identification code to specify the encoding table of prediction information, information to

indicate the valid time zone of prediction information, and encoded prediction information data are added. The prediction information includes a plurality of data items whose valid time zones differ from each other. From the traffic information transmitter 30, a shape vector encoding table, a traffic information quantization table, an encoding table of statistical prediction difference values of traffic information (Fig. 17(a)), and an encoding table of prediction information (Fig. 17(b)) are transmitted simultaneously or over an alternate route, on top of the shape data string information (a) and traffic information (b).

[0085]

<Change in resolution of prediction information>

The prediction information may be provided at a lower resolution as the prediction time advances into future, since prediction accuracy drops as prediction pertains to farther future. Fig. 21(b) schematically shows the provision of information where the position resolution is lowered and the traffic representation resolution is also lowered from the original information (Fig. 21(a)) in accordance with the future time. In case the position resolution is lowered, a plurality of quantization-units are merged into a single quantization-unit and the average value of data in each quantization-unit is used as the data in the resulting quantization-unit. In case the traffic representation resolution is lowered, a coarse quantization table is used to quantize data.

[0086]

Figs. 22(a) to 22(f) show a case where the statistical prediction difference value of prediction information is obtained while the position resolution is lowed from the original prediction information (a) and while the traffic information resolution is lowered by using a quantization table specifying coarseness at multiple levels shown in Fig. 23. In Fig. 22(b), the position resolution is lowered to half. An average traffic information value is obtained and the faction is dropped.

[0087]

In Fig. 22(c), the quantization table of "quantized volume (current)" in Fig. 23 is used to quantize prediction information and current information. In Fig. 22(d), the quantization table of "quantized volume (prediction 1)" in Fig. 23 is used to further quantize prediction information and lower the traffic representation resolution off prediction information. In Fig. 22(e), the difference between the current information quantized by using the quantization table of "quantized volume (prediction 1)" and the prediction information in Fig. 22(d) is extracted.

[0088]

In Fig. 22(f), a statistical prediction difference value is calculated assuming the value in the adjacent quantization-unit as a statistical prediction value concerning the prediction information obtained in Fig. 22(e) and the current information obtained in Fig. 22(c) (current information quantized by using the quantization table of "quantized volume (current)". While both of the position resolution and traffic representation resolution are modified in this example, resolution of either one may be lowered.

[0089]

While the position resolution of prediction information is lowered to half (the unit block length is doubled) in this example, it is possible to set the unit block length to any value exceeding 1.0 times (practically, setting of 1.5 times or 1.25 times is adequate since calculation

would be otherwise complicated). While the traffic representation resolution of prediction information is also lowered to half in this example, arbitrary setting is possible in the direction resolution gets coarser, although calculation is more complicated. The fraction at the tail in the direction of distance is difficult to calculate so that the "coarsest unit block length" is previously calculated and the unit block length is split by 2N from a practical point of view.

[0090]

The procedure of decoding is shown by (1) through (8) in the rightmost area of Fig. 22. Fig. 24 shows a data structure of traffic information assumed in case the resolution of prediction information is modified. For the prediction information in each valid time zone, a position resolution identification code (code indicating that the unit block length extends p times) and a quantization table number. In this way, for the prediction information, the resolution of information representation is modified in accordance with the future time of prediction to reduce the transmit data amount.

[0091]

<Variation example>

While a case has been described where a value in an adjacent quantization-unit in the direction of distance is used to calculate a statistical prediction difference value in this example, the statistical prediction value in a quantization-unit marked with a bullet may be set as follows considering both space and time, as shown in Fig. 25:

Statistical prediction value = a(1) ＋ b(2) ＋ c(3) (where a + b + c = 1) or =((1) ＋ (3)) ÷ 2

[0092]

(Third embodiment)

A third embodiment of the invention pertains to a method for translating the traffic information represented by a function of distance from the reference node into frequency components and representing the traffic information by the coefficient of each frequency component. Approaches to convert the data to a coefficient of frequency component includes FFT (fast Fourier Transform, DCT (discrete cosine transform), and wavelet transform. The FFT (fast Fourier Transform) which is the most popular is described below.

[0093]

The Fourier Transform is a transform process which uses a finite number of discrete values (sample values) to obtain a Fourier coefficient. The Fourier Transform refers to a process where a complex function C is associated with a discrete value represented by a complex function f:

$C(k)=(1/n)\Sigma f(j)\cdot\omega^{-jk}$ (k=0, 1, 2,..., n-1) (For Σ, add from j=0 to n-1) (Formula 1)

Note that ω=exp (2πi). C(k) is called a Fourier coefficient. N is an order.

[0094]

Conversely, a process where a complex function C is associated as shown below is called the inverse Fourier transform.

$f(j)=\Sigma C(k)\cdot\omega^{jk}$ (j=0, 1, 2, ... n-1) (For Σ, add from k=0 to n-1) (Formula 2)

In the Fourier Transform, when sampling interval δ = constant value and n = 2N with respect to a discrete value taken by the function f(j), the FFT (fast Fourier Transform) is available. Various FFT algorithms are proposed.

[0095]

Fig. 26 shows an example of experiment where traffic information is actually represented by a Fourier coefficient. Through this experiment example, the method for generating traffic information represented by a Fourier coefficient is described below. (1) "Original traffic information data" indicates the state quantity of traffic information at each sampling point (corresponding to the data in Fig. 1(b)). The number of data items is set to 25 (=32) so as to allow FFT. For FFT, it is possible to simultaneously transmit two information items by using the real part and imaginary part of a complex function so that "speed information" is set to the real part while "congestion information" is set to the imaginary part in this example. For FFT, values of comparable level generates less relative errors so that the congestion information is represented by "congestion=10, heavy traffic=20, light traffic=40" in line with the numeric value level of speed information. (2) In the FFT processing, the data (1) is represented by the imaginary part (a numeric value with "i" affixed at the tail represents an imaginary coefficient) to perform FFT and the FFT coefficient obtained is shown. (3) The quantization table corresponds to the "traffic information quantization table" in encoding/compression. The FFT coefficient under (2) is divided by a value in the quantization table (that is, quantized) to obtain "(4) transmit data". An FFT coefficient in this table is a coefficient of a low frequency as it is listed in a higher row while it is a coefficient of a high frequency as it is listed in a lower row. Thus, for a coefficient of a low frequency which has a greater influence, a smaller value in "(3) Quantization table" is set for more detailed representation. As the frequency rises, a value in "(3) Quantization table" is set for coarser representation.

[0096]

(4) The transmit data is obtained by quantizing the FFT coefficient under (2) by using the quantization table (3) (In case the value in the quantization table is 64, the real part and imaginary part of the FFT coefficient are divided by 64 and the fractional portion is rounded off). A higher-frequency component of the transmit data (4) is quantized in a coarser fashion so that the sixth row and after from the top contain smaller relative values, with values concentrating around "0". The transmit data (4) is variable length encoded/compressed then transmitted as mentioned later. (For an FFT coefficient which does not show the regularity, statistical difference processing is not particularly performed.) Resulting values concentrate around "0" which shows the compression effect of variable length encoding. To the receiving party, the quantization table (3) is transmitted also as table information necessary for decoding.

[0097]

(5) The inverse FFT performs inverse FFT on the received Fourier coefficient ((4)). First, the coefficient of each of the real part integer and imaginary part integer of the data received is reproduced based on the value in the "quantization table" (3) (when the value in the quantization table is 64, the real part and imaginary part of the received data is multiplied by 64 and the fractional portion is rounded off). The resulting value undergoes inverse FFT. (6) Reproduced traffic information data is obtained by rounding off the coefficient value of the real part and imaginary part of the inverse FFT coefficient obtained through inverse FFT and reproducing the real part to speed information and the imaginary part to congestion information.

[0098]

(7) Difference between original and reproduced data describes the difference between "reproduced data" and "measurement data". Although an error of maximum ±4 does exist, substantially the same value as the original "measurement data" is obtained. Especially for congestion information, an error of such a level can be eliminated in reproduction by previously negotiating "congestion=0-15; heavy traffic=16-25; light traffic=26 or more". Fig. 27 shows a case where the same measurement data as Fig. 26 is set in the quantization table (3) in a detailed fashion so that detailed data will be transmitted, similar to raw data. The difference between original and reproduced data (7) is much smaller than that in Fig. 26 and information is reproduced accurately. Note that the transmit data (4) has a wider high-frequency component range than that in Fig. 26 (variations around ±0 is noticeable). The information volume transmitted is larger and the effect of variable length encoding/compression is not found.

[0099]

Thus, in case traffic information is transformed to an FFT coefficient and is transmitted, the value in the quantization table may be adjusted to obtain data in the range from "transmit data whose information volume is large but which can accurately reproduce traffic information" to "data whose information volume is small and which reproduces traffic information at a low accuracy". It is thus possible to adjust the information volume while considering the position resolution described in the first embodiment. The configuration of a system which transforms traffic information to an FFT coefficient and provides the FFT coefficient is the same as that in Fig. 5.

[0100]

The flowchart of Fig. 28 shows the procedure in this system. The encoding table creating unit performs FFT to obtain an FFT coefficient (step 204), quantizes the FFT coefficient to calculate a quantization coefficients (step 205), calculates the distribution of quantization coefficients (step 207), calculates the distribution of run lengths (step 207), and accordingly creates an encoding table (step 208).

[0101]

The traffic information transmitter performs level alignment of traffic information set to the real part and imaginary part (step 218), performs FFT to transform the data to a Fourier coefficient, (step 219), and performs variable length encoding/compression on the Fourier coefficient (step 220). The receiving party apparatus references the encoding table and performs inverse Fourier Transform to decode the traffic information (step 234). The remaining procedures are same as those in Fig. 6.

[0102]

Fig. 30 shows an encoding table used for encoding.
Fig. 29 shows a data structure example of traffic information transmitted from the traffic information transmitter. The traffic information quantization table identification code corresponds to an identification number of the quantization table (3) in Fig. 26. The encoding table identification code represents an identification code in Fig. 30. For FFT, the number of data items transmitted (equivalent to the number of rows of the table in Fig. 27 × 2) is normally double the amount of block splitting between reference nodes. In case the high-frequency component is dropped before data is transmitted, the number of data items is different. This is

identified by the EOD code in the encoding table. In this practice, the receiving party assumes the Fourier coefficient of the high-frequency component as 0 in decoding. In this way, by sampling the traffic information in the direction of distance of a shape vector indicating a road, decomposing the traffic information function represented by the state quantity of each sampling point into frequency components, and encoding the coefficient value of each frequency and providing the obtained value, the receiver apparatus can reproduce the traffic information.

[0103]

This method is also applicable to the prediction information f the traffic information. For prediction information, the following approach is possible: the difference between the state quantity of traffic information in the time zone N and the state quantity of the traffic information (prediction information) in the time zone N+1 adjacent in terms of time is obtained. The difference state quantity at each sampling point may be transformed to each frequency component so that the coefficient value is encoded. The coefficient value of a high-frequency component among the coefficient values of the frequencies obtained through transform to a frequency component may be quantized to show deviation in the frequency of statistical occurrences and the coefficient value of each frequency after quantization is encoded so as to dramatically reduce the data volume. The coefficient value of a high-frequency component among the coefficient values of the frequencies obtained through transform to a frequency component may be deleted before encoding.

[0104]

(Fourth embodiment)

A fourth embodiment of the invention pertains to a special data transmission method for transmitting traffic information represented by a Fourier coefficient.

<Transmitting data by layer of frequency in order from low frequencies to high frequencies>

In this transmission method, traffic information is transmitted using a technique conforming to the progressive transmission system for image information. In the progressive transmission system for image information, the sending party (1) transmits all-pixel data of low frequency components at a time, (2) transmits the coefficients of high frequency components, and (3) transmits the coefficients of further high frequency components, ... The sending party repeats this processing. At the receiving party where the image is displayed, (1) a blurred image is displayed, (2) then the image gradually becomes more minute. In this case, the receiving party can determine an approximate image being sent before receiving all data, however slow the communications speed may be.

Thus, the receiving party can determine whether the image is "necessary or not" in an early stage. This data transmission method is also applicable to traffic information represented by the coefficient of each frequency after transform to a frequency component. The data transmission method is implemented by hierarchically organizing the coefficient value of each frequency representing traffic information by way of frequency and transmitting the coefficient values on a per layer basis.

[0105]

Figs. 31(a) and 31(b) show a data structure assumed when the traffic information is split. Fig. 31(a) shows the basic information and FFT coefficient information of low- frequency components. The information includes the "amount of traffic information splitting" to represent

the amount of splitting of components ranging from low frequencies to high frequencies and also the "number of this information" indicating the information's position in the sequence. Fig. 31(b) shows FFT coefficient information of high frequency components as split traffic information. This information also includes the "amount of traffic information splitting" and the "number of this information" although data items overlapping those in Fig. 31(a) are omitted.

[0106]

In case the traffic information transmission method is applied to provision of traffic information from the Internet, the user wishing to check traffic information on various websites of the Internet can check the general information of a website. The user can omit the details and visit another website. In case the user scrolls through traffic information along an expressway on the Internet, the user can check the general information and omit the details in order to fast scroll through traffic information.

[0107]

In case the user sequentially scrolls through past traffic information accumulated chronologically like an animation film, the user can proceed frame by frame in case a point of focus is likely not congested. The coefficient values of the frequencies on a plurality of roads for which information is provided may be transmitted from low frequencies to high frequencies in the order shown by the arrow in Fig. 32(b). Fig. 32(a) shows a normal transmission order for the purpose of comparison.

[0108]

<Backup using a plurality of transmission media>

In case the coefficient values of the frequencies are hierarchically organized by frequency and split into low-frequency components and high-frequency components as shown in Fig. 31, traffic information can be transmitted from more than one medium on a per layer basis. For example, a digital terrestrial broadcast provides shape vector data (position data) and coarse traffic information (low-frequency components of FFT coefficient) on all target roads in a wide area.

A beacon installed beside a road provides information which covers details of the traffic information provided by the digital terrestrial broadcast around the beacon's position. In this way, a wide-area broadcast-type medium provides public general information to let a beacon provide details on the local area.

[0109]

Fig. 33 shows a system configuration of this case. A traffic information transmitter 30 includes an information transmitter A (135) for providing traffic information via a wide-area medium A and an information transmitter B (235) for providing traffic information via a beacon (medium B). A receiving party apparatus 60 includes an information receiver A (161) for receiving information provided by the wide-area medium A (161) and an information receiver B (261) for receiving information provided by the beacon. The receiving party apparatus 60 uses the traffic information received by the information receiver A (161) and the traffic information received by the information receiver B (261) to reproduce the traffic information.

[0110]

In a system where a wide-area medium and a beacon backs each other up to provide traffic information, the wide-area medium need not transmit detailed information thus allowing

transmission of traffic information on a wider area. The receiving party apparatus can reproduce necessary traffic information based on the information obtained from a wide-area medium and a beacon at the local site near which the user's vehicle is traveling. It is possible to provide detailed information as a reply information from a beacon to a car-mounted machine which has provided probe information via a beacon. While the relation between a wide-area medium and a beacon has been described, any other combination of media which back each other up may be used.
A medium such as a cell phone may be used instead of a beacon.

[0111]

(Fifth embodiment)

A fifth embodiment of the invention pertains to a method for providing the latest traffic information by way of difference information from the last traffic information. In this method, an approach used to calculate the prediction information arranged chronologically on the time axis of future time (approach for obtaining the difference from the latest information in the preceding time zone as well as the difference from the latest information at an adjacent point and encoding the difference value) is applied to calculate the latest information in the time zones arranged chronologically on the real time axis. To calculate the latest information in the current time zone, the difference from the latest information in the preceding zone as well as the difference from the latest information at an adjacent point is obtained and the difference value is encoded.

[0112]

For the prediction information, the prediction information in each time zone can be displayed in the data format of traffic information in Fig. 20(b) and transmitted. The latest information on the real time axis can be transmitted only when the time has come. Thus, in his example, the data format of the traffic information shown in Fig. 20(b) is split into a data format of the base traffic information (Fig. 34(a)) and a data format of the traffic information representing prediction information in each time zone (Fig. 34(b)) and the latest information at the point in time is transmitted in the data format of the traffic information shown in Fig. 34(b) when the real time has come.

[0113]

Such traffic information includes the "amount of traffic information splitting" to represent the amount of splitting and the "number of this information" indicating the information's position in the sequence. In case the amount of splitting is N-1, in the first cycle, the base traffic information from the next cycle to the N-1 cycle is transmitted in the data format shown in Fig. 34(a), together wit the shape data string information. In the second cycle, the latest traffic information represented by the difference value from the information in the first cycle is transmitted in the data format shown in Fig. 34(b). In the third cycle, the latest traffic information represented by the difference value from the information in the second cycle is transmitted in the data format shown in Fig. 34(b). In the Nth cycle, the traffic information as the base of the next cycle and after is transmitted in the data format shown in Fig. 34(a), together wit the shape data string information.

[0114]

By doing so, the total information volume is reduced. The receiving party needs to

perform a smaller number of map matching processes so that the total performance of the system is enhanced. In case the history data of traffic information provided in the past is to be stored, the target data volume is small. In case real time traffic information is provided over the Internet or a service to show the past traffic information chronologically such as on an animation movie, the communications charge on the user is reduced.

[0115]

(Sixth embodiment)

A sixth embodiment of the invention pertains to application of this system to a storage medium. While the case where the traffic information generated by this invention is transmitted via communications has been described as a main application, the traffic information may be stored onto a storage medium such as a CD or a DVD, or exported to another terminal via a storage medium.

[0116]

Fig. 35 shows a system configuration of this case. A traffic information converter/recorder 330 includes an information accumulating unit 335 for accumulating the encoded traffic information. The information accumulating unit 335 accumulates the traffic information encoded by an encoder 34 into an internal storage medium 331 or an external storage medium 332. A traffic information reference/utilization apparatus 360 includes a decoder 362 for decoding encoded data. The decoder 362 reads the traffic information stored on the external storage medium or internal storage medium 361 and decodes the traffic information. The method for utilizing the decoded traffic information is the same as that in Fig. 5. In this way, the traffic information generated by the inventive method can be accumulated into an accumulation medium and utilized.

[0117]

(Seventh embodiment)

A seventh embodiment of the invention pertains to interactive provision of traffic information. In this system, as shown in Fig. 36, a client specifies the range of traffic information and data volume (data in excess of this volume is not necessary) and transmits request information for traffic information. A server provides the traffic information in response to the request. The client apparatus may be a car navigation system, a PC, or a portable terminal.

[0118]

Fig. 39 is a block diagram of this system. Client apparatus 460 includes: an input operation section 463 for the user to input a request; a display range/data size determination unit for determining the requested display range and data size; a request information transmitter for transmitting a request; a Response information receiver for receiving response information; a decoder 465 for decoding the encoded data; a traffic information utilization unit 466 for utilizing the reproduced traffic information; and a digital map database 467 referenced by the traffic information utilization unit 466. A server 430 includes: a request information receiver for receiving request information; a transmit traffic information area/detail level determination unit 432 for determining the area and detail level of traffic information to transmit; a traffic information quantization/coding unit 435 for encoding traffic information data 433 by using encoding table data 434; and a response information transmitter for transmitting encoded

traffic information.

[0119]

The flowchart of Fig. 38 shows the operation procedure of this system. The client apparatus 460 determines the range and desired data size of traffic information necessary for display or path search (step 310) and transmits a request to a server 430 (step 311). The server 430 which was awaiting a request from the client (step 300) receives request information from the client (step 301), determines the detail level of traffic information to transmit to the client from the request information (step 302), performs quantization and encoding of traffic information (step 303), and transmits the encoded traffic information and encoding table to the client (step 304). In this practice, the server 430 transmits data shown in Figs. 8(a) and 8(b) and Figs. 20(a) and 20(b) to the client. The client apparatus 460, receiving response information from the server 430 (step 312), references the encoding table to decode the traffic information represented by a code (step 313), performs map matching based on the position information (such as shape vector), identifies the position of received traffic information (step 314), thus utilizing the traffic information.

[0120]

Fig. 37 shows an example of the request information. The "desired maximum data size" may be a communications charge or communications time in the case of a packet billing system. The request range may be any of "latitude/longitude of lower left/upper right of rectangle", "center point", "prefectural/communal code", "road specification", "latitude/longitude of beginning/end for path search request", and "latitude/longitude of current position + travel direction". Or, any combination of these may be used. The transmit traffic information area/detail level determination unit 432 determines the detail level of traffic information so that the traffic information on the recommended path will be more detailed in case the traffic information has been requested based on the "latitude/longitude of beginning/end for path search request", and that the traffic information will be less detailed with distance from the recommended path. In case the traffic information is requested based on "latitude/longitude of current position + travel direction", the transmit traffic information area/detail level determination unit 432 determines the detail level of traffic information so that the traffic information in the travel direction near the current point and on the road the user is traveling along will be more detailed and less detailed with distance from the current point.

[0121]

In this way, in the interactive provision of information, it is possible to minutely adjust the resolution of information representation in the traffic information in accordance with a request. Adjustment is possible so that the prediction information around the predicted arrival time will be more detailed in accordance with the predicted travel time of arrival to each link and the prediction information will be less detailed as the time moves away from the predicted arrival time.

[0122]

[Advantage of the Invention]

As understood from the foregoing description, the traffic information provision system of the invention can arbitrarily set a position resolution and a traffic representation resolution and change the resolution of information representation on demand in accordance with the

importance of traffic information, and can flexibly support a "prediction service" of traffic information.

[Brief Description of the Drawings]

[Fig. 1] Figs. 1(a) to 1(d) show a method for calculating a statistical prediction difference value of traffic information in a first embodiment of the invention.

[Fig. 2] Fig. 2 shows a correlation used to generate traffic information in the first embodiment of the invention.

[Fig. 3] Fig. 3 shows a traffic information quantization table in the first embodiment of the invention.

[Fig. 4] Fig. 4 shows an encoding table of statistical prediction difference values in the first embodiment of the invention.

[Fig. 5] Fig. 5 is a system block diagram in the first embodiment of the invention.

[Fig. 6] Fig. 6 is a flowchart of operation of a system in the first embodiment of the invention.

[Fig. 7] Figs. 7(a) and 7(b) are data block diagrams of original information in the first embodiment of the invention.

[Fig. 8] Figs. 8(a) and 8(b) are data block diagrams of shape vector data and traffic information in the first embodiment of the invention.

[Fig. 9] Fig. 9 is a flowchart of a quantization-unit determination procedure in the first embodiment of the invention.

[Fig. 10] Figs. 10(a) and 10(b) show a quantization-unit determination tables in the first embodiment of the invention.

[Fig. 11] Fig. 11 is a flowchart of a quantization-unit determination procedure which is based on the distance from a recommended path in the first embodiment of the invention;

[Fig. 12] Fig. 12 is a flowchart of a preprocessing procedure in the first embodiment of the invention.

[Fig. 13] Figs. 13(a) and 13(b) show a peak and a dip in the first embodiment of the invention.

[Fig. 14] Fig. 14 is a flowchart of a procedure to delete a peak and a dip in the first embodiment of the invention.

[Fig. 15] Figs. 15(a) to 15(e) illustrate the difference representation of prediction information in a second embodiment of the invention.

[Fig. 16] Figs. 16(a) to 16(d) show a method for calculating a statistical prediction difference value in the second embodiment of the invention.

[Fig. 17] Figs. 17(a) and 17(b) show a statistical prediction difference value and prediction information in the second embodiment of the invention.

[Fig. 18] Fig. 18 is a system block diagram in a second embodiment of the invention.

[Fig. 19] Fig. 19 is a flowchart of operation of a system in the second embodiment of the invention.

[Fig. 20] Figs. 20(a) and 20(b) are data block diagrams of shape vector data and traffic information in the second embodiment of the invention.

[Fig. 21] Figs. 21(a) and 21(b) illustrate a change in information representation resolution of prediction information in the second embodiment of the invention.

[Fig. 22] Figs. 22(a) to 22(f) show a process of changing the information representation resolution of prediction information in the second embodiment of the invention.

[Fig. 23] Fig. 23 shows a traffic information quantization table of prediction information in the second embodiment of the invention.

[Fig. 24] Fig. 24 is a data block diagram of traffic information whose information representation resolution of prediction information has been modified in the second embodiment of the invention.

[Fig. 25] Fig. 25 shows an example of another statistical prediction value in the second embodiment of the invention.

[Fig. 26] Fig. 26 shows a quantization procedure using FFT in a third embodiment of the invention.

[Fig. 27] Fig. 27 shows a quantization procedure using FFT with the quantization table modified in the third embodiment of the invention.

[Fig. 28] Fig. 28 is a flowchart of operation of a system in the third embodiment of the invention.

[Fig. 29] Fig. 29 is a data block diagram of traffic information in FFT representation in the third embodiment of the invention.

[Fig. 30] Fig. 30 shows an encoding table of FFT coefficient in the third embodiment of the invention.

[Fig. 31] Figs. 31(a) and 31(b) are a data block diagram of traffic information in a fourth embodiment of the invention.

[Fig. 32] Figs. 32(a) and 32(b) show a procedure for transmitting traffic information in the fourth embodiment of the invention.

[Fig. 33] Fig. 33 is a system block diagram in the fourth embodiment of the invention.

[Fig. 34] Figs. 34(a) and 34(b) are data block diagrams of traffic information in a fifth embodiment of the invention.

[Fig. 35] Fig. 35 is a system block diagram in a sixth embodiment of the invention.

[Fig. 36] Fig. 36 illustrates an interactive system in a seventh embodiment of the invention.

[Fig. 37] Fig. 37 is a data block diagram of request information in the seventh embodiment of the invention.

[Fig. 38] Fig. 38 is a flowchart of operation of a system in the seventh embodiment of the invention.

[Fig. 39] Fig. 39 is a system block diagram in the seventh embodiment of the invention.

[Fig. 40] Fig. 40 illustrates a relative position correcting method using reference node in the related art.

[Fig. 41] Fig. 41 illustrates the problems with traffic information in the related art.

[Fig. 42] Fig. 42 illustrates the problems with the information display resolution of traffic information in the related art.

[Fig. 43] Figs. 43(a) and 43(b) illustrate the problems with transmission of traffic information in the related art.

[Fig. 44] Figs. 44(a) and 44(b) illustrate the concept of information display resolution.

[Description of the Reference Numerals and Signs]

10: TRAFFIC INFORMATION MEASUREMENT APPARATUS
11: SENSOR PROCESSOR A
12: SENSOR PROCESSOR B
13: SENSOR PROCESSOR C
14: TRAFFIC INFORMATION CALCULATOR
15: TRAFFIC INFORMATION/PREDICTION INFORMATION CALCULATOR
16: STATISTICAL INFORMATION
21: SENSOR A (ULTRASONIC VEHICLE SENSOR)
22: SENSOR B (AVI SENSOR)
23: SENSOR C (PROBE CAR)
30: TRAFFIC INFORMATION TRANSMITTER
31: TRAFFIC INFORMATION COLLECTOR
32: QUANTIZATION-UNIT DETERMINATION UNIT
33: TRAFFIC INFORMATION CONVERTER
34: ENCODER
35: INFORMATION TRANSMITTER
36: DIGITAL MAP DATABASE
50: ENCODING TABLE CREATING UNIT
51: ENCODING TABLE CALCULATING UNIT
52: ENCODING TABLE
53: TRAFFIC INFORMATION QUANTIZATION TABLE
54: DISTANCE QUANTIZATION-UNIT PARAMETER TABLE
60: RECEIVING PARTY APPARATUS
61: INFORMATION RECEIVER
62: DECODER
63: MAP MATCHING/ SECTION DETERMINATION UNIT
64: TRAFFIC INFORMATION REFLECTING UNIT
66: LINK COST TABLE
67: INFORMATION UTILIZATION UNIT
68: LOCAL VEHICLE POSITION DETERMINATION UNIT
69: GPS ANTENNA
70: GYROSCOPE
71: GUIDANCE APPARATUS
135: INFORMATION TRANSMITTER A
161: INFORMATION RECEIVER A
235: INFORMATION TRANSMITTER B
261: INFORMATION RECEIVER B
330: TRAFFIC INFORMATION CONVERTER/RECORDER
331: INTERNAL STORAGE MEDIUM
332: EXTERNAL STORAGE MEDIUM
335: INFORMATION ACCUMULATING UNIT
360: TRAFFIC INFORMATION REFERENCE/UTILIZATION APPARATUS

361: INTERNAL STORAGE MEDIUM
362: DECODER
430: SERVER
431: REQUEST INFORMATION RECEIVER
432: TRANSMIT TRAFFIC INFORMATION AREA/DETAIL LEVEL DETERMINATION UNIT
433: TRAFFIC INFORMATION DATA
434: ENCODING TABLE DATA
435: TRAFFIC INFORMATION QUANTIZATION/CODING UNIT
436: RESPONSE INFORMATION TRANSMITTER
460: CLIENT APPARATUS
461: REQUEST INFORMATION TRANSMITTER
462: DISPLAY RANGE/DATA SIZE DETERMINATION UNIT
463: INPUT OPERATION SECTION
464: RESPONSE INFORMATION RECEIVER
465: DECODER
466: TRAFFIC INFORMATION UTILIZATION UNIT
467: DIGITAL MAP DATABASE

[Designation of Document] ABSTRACT

[Abstract]

[Task] An object of the invention is to provide a traffic information provision system which can arbitrarily set a position resolution and a traffic representation resolution and flexibly support a traffic information prediction service.

[Means for Resolution] The traffic information provision system of the invention quantizes the state quantity of traffic information changing along a road, converts the quantized state quantity to a value having statistical deviation, performs encoding of the value, and provides the encoded value to traffic information utilization apparatus such as a car navigation system. The traffic information utilization apparatus decodes the encoded state quantity to reproduce the traffic information on the road.

[Selected Drawing] Fig. 1

[Designation of Document] DRAWINGS

[Fig. 1]

REFERENCE NODE OF SHAPE VECTOR

DISTANCE Xm

(b) QUANTIZATION OF SAMPLING POINT IN THE DIRECTION OF DISTANCE

->: DISTANCE Xm

(c) QUANTIZATION OF TRAFFIC INFORMATION (SPEED)

(d) DIFFERENCE REPRESENTATION BASED ON STATISTIC PREDICTION VALUE

[Fig. 2]

↑: TIME

DISTANT FUTURE

10 MINUTES LATER

5 MINUTES LATER

NOW

→: DISTANCE OF SHAPE VECTOR

REFERENCE NODE (STARTING POINT)

REFERENCE NODE

REFERENCE NODE

REFERENCE NODE

(1) CORRELATION STRENGTH

(2) CORRELATION STRENGTH

(3) CORRELATION STRENGTH

(4) CORRELATION STRENGTH

[Fig. 3]

TRAFFIC INFORMATION QUANTIZATION TABLE (SPEED QUANTIZATION TABLE)

QUANTIZED VOLUME	SPEED (km/h)
~	~
30	200 OR MORE

[Fig. 4]

EXEMPLARY ENCODING TABLE OF STATISTICAL PREDICTION DIFFERENCE VALUE OF TRAFFIC INFORMATION

SPECIAL CODE	CODE	OVERHEAD BIT
BLOCK LENGTH CHANGE CODE	101	3(40/80/160/···/5120m)
TRAFFIC INFORMATION QUANTIZATION TABLE CHANGE CODE	111110	4(TABLE NUMBER)

REFERENCE-NODE-RELATED POINT IDENTIFICATION CODE		1100	6(CORRESPONDING REFERENCE NODE NUMBER) + 8(OFFSET DISTANCE FROM REFERENCE NODE)	
ENCODING TABLE OF STATISTICAL PREDICTION DIFFERENCE VALUES OF TRAFFIC INFORMATION		CODE	OVERHEAD BIT I	OVERHEAD BIT II (RANGE)
RUN LENGTH	CHANGE AMOUNT			
0	0	0	0	-
5	0	100	0	-
10	0	1101	0	-
0	±1	1110	1(±IDENTIFICATION)	0
0	±2	111100	1(±IDENTIFICATION)	0
0	±4	111101	1(±IDENTIFICATION)	1 (3 or 4)
		~		

[Fig. 5]

EXEMPLARY SYSTEM CONFIGURATION (APPLICATION FOR CAR NAVIGATION AND THE LIKE)

50: ENCODING TABLE CREATING UNIT

51: ENCODING TABLE CALCULATING UNIT

52: ENCODING TABLE

53: TRAFFIC INFORMATION QUANTIZATION TABLE (1)

54: DISTANCE QUANTIZATION-UNIT PARAMETER TABLE

60: RECEIVING PARTY APPARATUS

61: INFORMATION RECEIVER

62: DECODER

63: MAP MATCHING & SECTION DETERMINATION UNIT

64: TRAFFIC INFORMATION REFLECTING UNIT

65: DIGITAL MAP DATABASE B

66: LINK COST TABLE

67: INFORMATION UTILIZATION UNIT (ROUTE CALCULATION, GUIDANCE, SCREEN DISPLAY, AND THE LIKE)

68: LOCAL VEHICLE POSITION DETERMINATION UNIT

69: GPS ANTENNA

70: GYROSCOPE

71: GUIDANCE APPARATUS

30: TRAFFIC INFORMATION TRANSMITTER

31: TRAFFIC INFORMATION COLLECTOR

32: QUANTIZATION-UNIT DETERMINATION UNIT (□2)

33: TRAFFIC INFORMATION CONVERTER

34: ENCODER

35: INFORMATION TRANSMITTER

36: DIGITAL MAP DATABASE A

52: ENCODING TABLE

53: TRAFFIC INFORMATION QUANTIZATION TABLE (1)

10: TRAFFIC INFORMATION MEASUREMENT APPARATUS

11: SENSOR PROCESSOR A

12: SENSOR PROCESSOR B

13: SENSOR PROCESSOR C

14: TRAFFIC INFORMATION CALCULATOR

21: SENSOR A (ULTRASONIC VEHICLE SENSOR)

22: SENSOR B (AVI SENSOR)

23: SENSOR C (PROBE CAR)

[Fig. 6]

ENCODING TABLE CREATING UNIT

START

St. 1: SUMMARIZE TRAFFIC INFORMATION OF PAST TRAFFIC SITUATION OF PATTERN L

St. 2: SET QUANTIZATION-UNIT M IN THE DIRECTION OF DISTANCE

St. 3: SET TRAFFIC INFORMATION QUANTIZATION TABLE N

St. 4: CALCULATE STATISTICAL PREDICTION DIFFERENCE VALUES OF TRAFFIC INFORMATION ON THE BASIS OF FORMULA FOR CALCULATING STATISTICAL PREDICTION VALUE

St. 5: CALCULATE DISTRIBUTION OF STATISTICAL PREDICTION DIFFERENCE VALUES

St. 6: CALCULATE DISTRIBUTION OF RUN LENGTHS

St. 7: CREATE ENCODING TABLE BASED ON DISTRIBUTION OF STATISTICAL PREDICTION DIFFERENCE VALUES AND RUN LENGTHS

St. 8: COMPLETE ENCODING TABLE FOR CASE L-M-N

St. 9: ARE ALL CASES OF L-M-N COMPLETE?

END

TRAFFIC INFORMATION TRANSMITTER

START

St. 10: COLLECT TRAFFIC INFORMATION AND DETERMINE TRAFFIC INFORMATION PROVISION SECTION

St. 11: TRAFFIC INFORMATION PROVISION SECTION V = 1

St. 12: GENERATE SHAPE VECTOR AROUND TRAFFIC INFORMATION PROVISION SECTION V AND SET REFERENCE NODE

St. 13: PERFORM IRREVERSIBLE COMPRESSION OF SHAPE VECTOR

St. 14: DETERMINE TRAFFIC SITUATION AND DETERMINE QUANTIZATION LEVEL

St. 15: PERFORM SAMPLING IN THE DIRECTION OF DISTANCE

St. 16: CALCULATES TRAFFIC INFORMATION PER QUANTIZATION-UNIT

St. 17: PERFORM PREPROCESSING OF TRAFFIC INFORMATION

St. 18: PERFORM QUANTIZATION OF TRAFFIC INFORMATION

St. 19: CONVERT QUANTIZED TRAFFIC INFORMATION TO STATISTICAL PREDICTION DIFFERENCE VALUE

St. 20: EXECUTE VARIABLE LENGTH ENCODING/COMPRESSION OF QUANTIZED TRAFFIC INFORMATION BY USING ENCODING TABLE

St. 21: CORRECT UNIT BLOCK LENGTH (OR EACH THEREOF)

St. 22: V = V + 1

St. 23: IS THIS PROCESSING EXECUTED FOR ALL TRAFFIC INFORMATION PROVISION SECTION V?

St. 24: CONVERT ENCODED DATA TO TRANSMISSION DATA

St. 25: TRANSMIT DATA TOGETHER WITH THE ENCODING TABLE

END

INFORMATION RECEIVER

START

St. 30: RECEIVE DATA

St. 31: TRAFFIC INFORMATION PROVISION SECTION V = 1

St. 32: DECODE SHAPE VECTOR AND PERFORM MAP MATCHING TO IDENTIFY THE TARGET ROAD SECTION

St. 33: CORRECT UNIT BLOCK LENGTH (OR EACH THEREOF)

St. 34: DECODE TRAFFIC INFORMATION REFERRING TO ENCODING TABLE

St. 35: REFLECT DECODED TRAVEL TIME OF UNIT BLOCK (OR EACH THEREOF) ON LOCAL SYSTEM (LINK COST REFLECTION AND THE LIKE)

St. 36: V = V + 1

St. 37: IS THIS PROCESSING EXECUTED FOR ALL TRAFFIC INFORMATION PROVISION SECTION V

St. 38: UTILIZE PROVIDED TRAVEL TIME TO EXECUTE APPLICATION PROCESS (REQUIRED TIME DISPLAY AND ROUTE GUIDANCE)

END

[Fig. 7]

(a) DATA STRUCTURE EXAMPLE OF MAP DATA

MANAGEMENT INFORMATION (INFORMATION TYPE / SECTION DEFINITION)	
THE NUMBER OF NODES N NODE No. 1 NODE ATTRIBUTE INFORMATION OF NODE 1	
LONGITUDE OF NODE 1	LATITUDE OF NODE 1

THE NUMBER OF NODES BEING ADJACENT TO NODE 1

ADJACENT NODE No. 1	LINK No. 1-1
~	
ADJACENT NODE No. m	LINK No. 1-m

~~

NODE No. N

NODE ATTRIBUTE INFORMATION OF NODE N

LONGITUDE OF NODE N	LATITUDE OF NODE N

THE NUMBER OF NODES BEING ADJACENT TO NODE N

ADJACENT NODE No. 1	LINK No. N-1
~	
ADJACENT NODE No. m	LINK No. N-m

THE NUMBER OF LINKS L

LINK No. 1

LINK ATTRIBUTE INFORMATION OF LINK 1

THE NUMBER OF COMPONENT POINTS

LONGITUDE OF INTERPOLATION POINT 1-1	LATITUDE OF INTERPOLATION POINT 1-1
~	
LONGITUDE OF INTERPOLATION POINT 1-p	LATITUDE OF INTERPOLATION POINT 1-p

~~

LINK No. L

LINK ATTRIBUTE INFORMATION OF LINK L

THE NUMBER OF COMPONENT POINTS

LONGITUDE OF INTERPOLATION POINT L-1	LATITUDE OF INTERPOLATION POINT L-1
~	
LONGITUDE OF INTERPOLATION POINT L-p	LATITUDE OF INTERPOLATION POINT L-p

(b) TRAFFIC INFORMATION DATA EXAMPLE (EXAMPLE OF TRAVEL TIME / SPEED)

MAP DATA LINK No. 1

NOW: TRAVEL TIME	NOW: SPEED
5 MINUTES LATER: TRAVEL TIME	5 MINUTES LATER: SPEED
10 MINUTES LATER: TRAVEL TIME	10 MINUTES LATER: SPEED
~	
Z MINUTES LATER: TRAVEL TIME	Z MINUTES LATER: SPEED

~~

MAP DATA LINK No. K

NOW: TRAVEL TIME	NOW: SPEED

5 MINUTES LATER: TRAVEL TIME	5 MINUTES LATER: SPEED
10 MINUTES LATER: TRAVEL TIME	10 MINUTES LATER: SPEED
~	
Z MINUTES LATER: TRAVEL TIME	Z MINUTES LATER: SPEED
~~	

[Fig. 8]

(a) SHAPE DATA STRING INFORMATION (ENCODED/COMPRESSED DATA)

HEADER INFORMATION	
THE NUMBER OF SHAPE VECTORS N	
SHAPE DATA IDENTIFICATION NUMBER = 1	
ENCODING TABLE IDENTIFICATION CODE	
LONGITUDE INFORMATION OF MAP DATA SERVING AS SHAPE DATA SOURCE	
ONE-WAY DIRECTION (POSITIVE/NEGATIVE/NIL)	
BEGINNING NODE No. ps	
X-DIRECTIONAL ABSOLUTE COORDINATE OF NODE ps (LONGITUDE)	
Y-DIRECTIONAL ABSOLUTE COORDINATE OF NODE ps (LATITUDE)	
ABSOLUTE AZIMUTH OF NODE ps	
ps POSITION ERROR (m)	ps AZIMUTH ERROR (°)
MAXIMUM POSITION ERROR OF ENCODED SHAPE DATA (m)	MAXIMUM AZIMUTH ERROR OF ENCODED SHAPE DATA (°)
THE FOLLOWING INFORMATION IS ALSO ADDED TO ENCODED SHAPE DATA • REFERENCE NODE SETTING CODE • BLOCK LENGTH CHANGE CODE • EOD CODE	
END NODE No. pe	
X-DIRECTIONAL ABSOLUTE COORDINATE OF NODE pe (LONGITUDE)	
Y-DIRECTIONAL ABSOLUTE COORDINATE OF NODE pe (LATITUDE)	
ABSOLUTE AZIMUTH OF NODE pe	
pe POSITION ERROR (m)	pe AZIMUTH ERROR (°)
~	
SHAPE DATA IDENTIFICATION NUMBER = M	
~	

(b) TRAFFIC INFORMATION

HEADER INFORMATION	
THE NUMBER OF TRAFFIC INFORMATION PROVISION SECTIONS V	
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1	
REFERENCE SHAPE VECTOR STRING NUMBER = N	
DIRECTION IDENTIFICATION FLAG (POSITIVE/NEGATIVE)	
BEGINNING REFERENCE NODE Pa	END REFERENCE NODE Pb

IDENTIFICATION CODE OF QUANTIZED BLOCK LENGTH IN THE DIRECTION OF DISTANCE
IDENTIFICATION CODE OF TRAFFIC INFORMATION QUANTIZATION TABLE
IDENTIFICATION CODE OF ENCODING TABLE
THE NUMBER OF QUANTIZED UNIT SECTIONS
TRAFFIC INFORMATION OF THE BEGINNING (INITIAL VALUE)
THE FOLLOWING INFORMATION IS ALSO ADDED TO TRAFFIC INFORMATION ENCODED BY USING STATISTICAL PREDICTION DIFFERENCE VALUE • BLOCK LENGTH CHANGE CODE AND BLOCK LENGTH AFTER CHANGE • TRAFFIC INFORMATION QUANTIZATION TABLE CHANGE CODE AND TABLE NUMBER AFTER CHANGE • REFERENCE-NODE-RELATED POINT IDENTIFICATION CODE AND CORRESPONDING REFERENCE NODE NUMBER + OFFSET DISTANCE
~
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = W
~

[Fig. 9]

START

St. 40: DETERMINE TARGET DATA SIZE IN ACCORDANCE WITH TRANSMISSION CAPACITY

St. 41: DETERMINE EXPANSION RATIO (OR REDUCTION RATIO) OF TARGET DATA ON THE BASIS OF ORIGINAL DATA SIZE OF TRAFFIC INFORMATION IN THIS CYCLE, ORIGINAL DATA SIZE OF TRAFFIC INFORMATION IN THE LAST CYCLE, AND COMPRESSED DATA SIZE

St. 42: DETERMINE TRAFFIC SITUATION PATTERN L ON THE BASIS OF THE CURRENT TRAFFIC SITUATION

St. 43: PROVISION SECTION NUMBER W = 1

St. 44: EXTRACT PROVISION SECTION W AROUND TRANSMISSION POINT

St. 45: DETERMINE IMPORTANCE OF INFORMATION OF SECTION W FROM ATTRIBUTE OF MAP DATA LINK OF SECTION W, ROAD STRUCTURE, TRAFFIC VOLUME, TRAFFIC SITUATION, AND DISTANCE BETWEEN THE BARYCENTER POSITION OF SECTION W AND THE TRANSMISSION POINT

St. 46: DETERMINE QUANTIZATION-UNIT (Mw, Nw) ON THE BASIS OF EXPANSION RATIO (OR REDUCTION RATIO) OF TARGET DATA AND IMPORTANCE OF INFORMATION OF SECTION W

St. 47: W = W + 1

St. 48: IS THIS PROCESSING PERFORMED FOR ALL TRAFFIC INFORMATION PROVISION SECTIONS AROUND TRANSMISSION POINT?

END

[Fig. 10]

(a)

EXPANSION RATIO OF TARGET DATA	IMPORTANCE OF INFORMATION A	IMPORTANCE OF INFORMATION B	IMPORTANCE OF INFORMATION C	NOTE
DEFAULT	RANK 2	RANK 3	RANK 4	-
2.0 TIMES OR MORE	+1 RANK	+2 RANK	+3 RANK	INCREASE IN DETAIL
1.6~1.9 TIMES	±0 RANK	+1 RANK	+2 RANK	↑
1.1~1.3 TIMES	±0 RANK	±0 RANK	+1 RANK	↑
1.0 TIMES	±0 RANK	±0 RANK	±0 RANK	NO CHANGE
0.7~0.9 TIMES	±0 RANK	±0 RANK	-1 RANK	↓
0.6~0.5 TIMES	±0 RANK	-1 RANK	-2 RANK	↓
0.4 TIMES OR LESS	-1 RANK	-2 RANK	-3 RANK	DECREASE IN DETAIL

(b)

QUANTIZATION UNIT RANK	QUANTIZATION UNIT IN THE DIRECTION OF DISTANCE M	TRAFFIC INFORMATION QUANTIZATION TABLE	DETAIL LEVEL
RANK 1	50 m	TABLE 1	MORE DETAIL
RANK 2	100 m	TABLE 2	DETAIL
RANK 3	150 m	TABLE 2	NORMAL
RANK 4	200 m	TABLE 3	COARSE
RANK 5	200 m	TABLE 4	MORE COARSE

[Fig. 11]

START

St. 50: COLLECT INFORMATION ON RECOMMENDED PATH

St. 51: DETERMINE TRAFFIC SITUATION PATTERN L ON THE BASIS OF THE CURRENT TRAFFIC SITUATION

St. 52: DETERMINE PATH QUANTIZATION-UNIT (M0, N0)

St. 53: PROVISION SECTION NUMBER W = 1

St. 54: EXTRACT PROVISION SECTION W AROUND PATH

St. 55: CALCULATE THE BARYCENTER OF SECTION W, AND CALCULATE THE DISTANCE OF PERPENDICULAR FROM THE BARYCENTER TO RECOMMENDED PATH

St. 56: DETERMINE QUANTIZATION-UNIT (Mw, Nw) OF SECTION W ON THE BASIS OF PERPENDICULAR DISTANCE

St. 57: W = W + 1

St. 58: IS THIS PROCESSING PERFORMED FOR ALL TRAFFIC INFORMATION PROVISION SECTIONS AROUND TRANSMISSION POINT?

END

[Fig. 12]

START

St. 60: QUANTIZED UNIT SECTION NUMBER p = 0

St. 61: p = p + 1

St. 62: COLLECT TRAFFIC INFORMATION Tp OF EACH OF THE TOTAL N SECTIONS STARTING WITH SECTION p AND THOSE IMMEDIATELY BEFORE AND AFTER p

St. 63: REPLACE TRAFFIC INFORMATION Tp WITH THE WEIGHTED AVERAGE OF TRAFFIC INFORMATION OF PRECEDING AND SUBSEQUENT SECTIONS, WHERE $Tp = (\Sigma ai \times Ti)/N \quad \therefore \Sigma ai=1$

St. 64: IS THIS PROCESSING PERFORMED FOR ALL QUANTIZATION SECTIONS?

END

[Fig. 13]

(a) PEAK (WHEN DIFFERENCE BETWEEN PRECEDING AND SUBSEQUENT TRAFFIC INFORMATION VOLUMES EXCEEDS PRESPECIFIED VALUE)

(b) DIP (WHEN DIFFERENCE BETWEEN PRECEDING AND SUBSEQUENT TRAFFIC INFORMATION VOLUMES EXCEEDS PRESPECIFIED VALUE)

[Fig. 14]

START

St. 70: QUANTIZED UNIT SECTION NUMBER p = 1

St. 71: COLLECT TRAFFIC INFORMATION Tp OF N SECTIONS FROM UNIT SECTION P

St. 72: SEARCH FOR PEAKS AND DIPS OF TRAFFIC INFORMATION IN THE SECTION p THROUGH SECTION p+N

St. 73: REPLACE PEAK OR DIP WITH AVERAGE VALUE OF TRAFFIC INFORMATION OF THE PRECEDING SECTION AND SUBSEQUENT SECTION WHEN WIDTH OF PEAK OR DIP IS BELOW PRESPECIFIED VALUE

St. 74: p = p + N + 1

IS THIS PROCESSING PERFORMED FOR ALL QUANTIZATION SECTIONS?

END

[Fig. 15]

->: CHANGE POINT EXTRACTION (UPSTREAM DIFFERENCE)

->: CHANGE POINT EXTRACTION (UPSTREAM DIFFERENCE)

(a)

TIME ZONE N+1 (FUTURE INFORMATION)

(b)

TRAFFIC INFORMATION (TRAVEL TIME PER UNIT SECTION)

TIME ZONE N

NON-CONGESTION, CONGESTION, NON-CONGESTION, CONGESTION
DISTANCE

(c)

DIFFERENCE EXTRACTION
(N + 1) – N

(d)

CHANGE POINT (EDGE INFORMATION)
(i) IT IS THE SAME AS ENCODING METHOD OF THE CURRENT INFORMATION

(e)

(ii) DIFFERENCE FROM TRAFFIC INFORMATION IS OBTAINED, AND DIFFERENCE FROM UPSTREAM IS OBTAINED

[Fig. 16]

CALCULATION EXAMPLE OF (ii)

(a)

1. ORIGINAL TRAFFIC INFORMATION (THE CURRENT MEASUREMENT VALUE + PREDICTION INFORMATION OF THE NEXT TIME ZONE)
PREDICTION INFORMATION OF THE NEXT TIME ZONE
THE CURRENT INFORMATION

(b)

2. QUANTIZATION REPRESENTATION OF TRAFFIC INFORMATION
INFORMATION CONCENTRATES AROUND ±0 BY CORRELATION LAW B

(c)

3. PREDICTION INFORMATION IS REPRESENTED BY DIFFERENCE FROM THE CURRENT INFORMATION (THE CURRENT INFORMATION IS REPRESENTED BY DIFFERENCE FROM ADJACENT UNIT SECTION)
INFORMATION CONCENTRATES AROUND ±0 BY CORRELATION LAW C

(d)

4. IN ADDITION, PREDICTION INFORMATION IS REPRESENTED BY DIFFERENCE FROM ADJACENT UNIT SECTION

[Fig. 17]

(a)

EXEMPLARY ENCODING TABLE OF STATISTICAL PREDICTION DIFFERENCE VALUE OF TRAFFIC INFORMATION (WHICH IS THE SAME AS THAT PREVIOUSLY DESCRIBED)

SPECIAL CODE	CODE	OVERHEAD BIT
BLOCK LENGTH CHANGE CODE	101	3(40/80/160/···/5120m)
TRAFFIC INFORMATION QUANTIZATION TABLE CHANGE CODE	111110	4(TABLE NUMBER)

<table>
<tr><td colspan="2">REFERENCE-NODE-RELATED POINT IDENTIFICATION CODE</td><td>1100</td><td colspan="2">6(CORRESPONDING REFERENCE NODE NUMBER) + 8(OFFSET DISTANCE FROM REFERENCE NODE)</td></tr>
<tr><td colspan="2">ENCODING TABLE OF STATISTICAL PREDICTION DIFFERENCE VALUES OF TRAFFIC INFORMATION</td><td rowspan="2">CODE</td><td rowspan="2">OVERHEAD BIT I</td><td rowspan="2">OVERHEAD BIT II (RANGE)</td></tr>
<tr><td>RUN LENGTH</td><td>CHANGE AMOUNT</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td>5</td><td>0</td><td>100</td><td>0</td><td>-</td></tr>
<tr><td>10</td><td>0</td><td>1101</td><td>0</td><td>-</td></tr>
<tr><td>0</td><td>±1</td><td>1110</td><td>1(±IDENTIFICATION)</td><td>0</td></tr>
<tr><td>0</td><td>±2</td><td>111100</td><td>1(±IDENTIFICATION)</td><td>0</td></tr>
<tr><td>0</td><td>±4</td><td>111101</td><td>1(±IDENTIFICATION)</td><td>1 (3 or 4)</td></tr>
<tr><td colspan="5">~</td></tr>
</table>

(b)

EXEMPLARY ENCODING TABLE OF PREDICTION INFORMATION

<table>
<tr><td colspan="2">SPECIAL CODE</td><td>CODE</td><td colspan="2">OVERHEAD BIT</td></tr>
<tr><td colspan="5">NIL</td></tr>
<tr><td colspan="2">ENCODING TABLE OF STATISTICAL PREDICTION DIFFERENCE VALUES OF TRAFFIC INFORMATION</td><td rowspan="2">CODE</td><td rowspan="2">OVERHEAD BIT I</td><td rowspan="2">OVERHEAD BIT II (RANGE)</td></tr>
<tr><td>RUN LENGTH</td><td>CHANGE AMOUNT</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td>5</td><td>0</td><td>100</td><td>0</td><td>-</td></tr>
<tr><td>10</td><td>0</td><td>1101</td><td>0</td><td>-</td></tr>
<tr><td>0</td><td>±1</td><td>1110</td><td>1(±IDENTIFICATION)</td><td>0</td></tr>
<tr><td>0</td><td>±2</td><td>111100</td><td>1(±IDENTIFICATION)</td><td>0</td></tr>
<tr><td>0</td><td>±4</td><td>111101</td><td>1(±IDENTIFICATION)</td><td>1 (3 or 4)</td></tr>
<tr><td colspan="5">~</td></tr>
</table>

[Fig. 18]

EXEMPLARY SYSTEM CONFIGURATION (APPLICATION FOR CAR NAVIGATION AND THE LIKE)

ENCODING TABLE CREATING UNIT

ENCODING TABLE CALCULATING UNIT

ENCODING TABLE

TRAFFIC INFORMATION QUANTIZATION TABLE (1)
DISTANCE QUANTIZATION-UNIT PARAMETER TABLE
RECEIVING PARTY APPARATUS
INFORMATION RECEIVER
DECODER
MAP MATCHING & SECTION DETERMINATION UNIT
TRAFFIC INFORMATION AND PREDICTION INFORMATION REFLECTING UNIT
DIGITAL MAP DATABASE B
LINK COST TABLE
INFORMATION UTILIZATION UNIT (ROUTE CALCULATION, GUIDANCE, SCREEN DISPLAY, AND THE LIKE)
LOCAL VEHICLE POSITION DETERMINATION UNIT
GPS ANTENNA
GYROSCOPE
GUIDANCE APPARATUS
30: TRAFFIC INFORMATION TRANSMITTER
TRAFFIC INFORMATION AND PREDICTION INFORMATION COLLECTOR
QUANTIZATION-UNIT DETERMINATION UNIT (□2)
TRAFFIC INFORMATION CONVERTER (□ INCLUDING THREE PROCESSING)
ENCODER
INFORMATION TRANSMITTER
DIGITAL MAP DATABASE A
ENCODING TABLE
TRAFFIC INFORMATION QUANTIZATION TABLE (1)
10: TRAFFIC INFORMATION MEASUREMENT APPARATUS
11: SENSOR PROCESSOR A
12: SENSOR PROCESSOR B
13: SENSOR PROCESSOR C
15: TRAFFIC INFORMATION AND PREDICTION INFORMATION CALCULATOR
16: STATISTICAL INFORMATION
SENSOR A (ULTRASONIC VEHICLE SENSOR)
SENSOR B (AVI SENSOR)
SENSOR C (PROBE CAR)

[Fig. 19]
ENCODING TABLE CREATING UNIT
START
SUMMARIZE TRAFFIC INFORMATION OF PAST TRAFFIC SITUATION OF PATTERN L
SET QUANTIZATION-UNIT M IN THE DIRECTION OF DISTANCE

SET TRAFFIC INFORMATION QUANTIZATION TABLE N

ENCODING TABLE OF TRAFFIC INFORMATION IS COMPLETE

St. 104: CALCULATE STATISTICAL PREDICTION DIFFERENCE VALUES OF PREDICTION INFORMATION ON THE BASIS OF FORMULA FOR CALCULATING STATISTICAL PREDICTION VALUE

St. 105: CALCULATE DISTRIBUTION OF STATISTICAL PREDICTION DIFFERENCE VALUES

St. 106: CALCULATE DISTRIBUTION OF RUN LENGTHS

St. 107: CREATE PREDICTION INFORMATION ENCODING TABLE BASED ON DISTRIBUTION OF STATISTICAL PREDICTION DIFFERENCE VALUES AND RUN LENGTHS

St. 108: COMPLETE ENCODING TABLE FOR CASE L-M-N

ARE ALL CASES OF L-M-N COMPLETE?

END

TRAFFIC INFORMATION TRANSMITTER

START

COLLECT TRAFFIC INFORMATION AND PREDICTION INFORMATION, AND DETERMINE TRAFFIC INFORMATION PROVISION SECTION

TRAFFIC INFORMATION PROVISION SECTION V = 1

GENERATE SHAPE VECTOR AROUND TRAFFIC INFORMATION PROVISION SECTION V AND SET REFERENCE NODE

PERFORM IRREVERSIBLE COMPRESSION OF SHAPE VECTOR

DETERMINE TRAFFIC SITUATION AND DETERMINE QUANTIZATION LEVEL

PERFORM SAMPLING IN THE DIRECTION OF DISTANCE

St. 116: CALCULATES TRAFFIC INFORMATION AND PREDICTION INFORMATION PER QUANTIZATION-UNIT

St. 117: PERFORM PREPROCESSING OF TRAFFIC INFORMATION AND PREDICTION INFORMATION

St. 118: PERFORM QUANTIZATION OF TRAFFIC INFORMATION AND PREDICTION INFORMATION

St. 119: CONVERT QUANTIZED TRAFFIC INFORMATION AND PREDICTION INFORMATION TO STATISTICAL PREDICTION DIFFERENCE VALUE

St. 120: EXECUTE VARIABLE LENGTH ENCODING/COMPRESSION OF QUANTIZED TRAFFIC INFORMATION AND PREDICTION INFORMATION BY USING ENCODING TABLE

CORRECT UNIT BLOCK LENGTH (OR EACH THEREOF)

V = V + 1

IS THIS PROCESSING EXECUTED FOR ALL TRAFFIC INFORMATION PROVISION SECTION V?

CONVERT ENCODED DATA TO TRANSMISSION DATA

TRANSMIT DATA TOGETHER WITH THE ENCODING TABLE

END

INFORMATION RECEIVER

START

RECEIVE DATA

TRAFFIC INFORMATION PROVISION SECTION V = 1

DECODE SHAPE VECTOR AND PERFORM MAP MATCHING TO IDENTIFY THE TARGET ROAD SECTION

CORRECT UNIT BLOCK LENGTH (OR EACH THEREOF)

DECODE TRAFFIC INFORMATION AND PREDICTION INFORMATION REFERRING TO ENCODING TABLE

REFLECT DECODED TRAVEL TIME OF UNIT BLOCK (OR EACH THEREOF) ON LOCAL SYSTEM (LINK COST REFLECTION AND THE LIKE)

V = V + 1

IS THIS PROCESSING EXECUTED FOR ALL TRAFFIC INFORMATION PROVISION SECTION V

UTILIZE PROVIDED TRAVEL TIME TO EXECUTE APPLICATION PROCESS (REQUIRED TIME DISPLAY AND ROUTE GUIDANCE)

END

[Fig. 20]

DATA STRUCTURE EXAMPLE OF THIS SYSTEM (INFORMATION REPLACEMENT FORMAT)

(a) SHAPE DATA STRING INFORMATION (THE SAME AS PREVIOUSLY DESCRIBED)

HEADER INFORMATION	
THE NUMBER OF SHAPE VECTORS N	
SHAPE DATA IDENTIFICATION NUMBER = 1	
ENCODING TABLE IDENTIFICATION CODE	
LONGITUDE INFORMATION OF MAP DATA SERVING AS SHAPE DATA SOURCE	
ONE-WAY DIRECTION (POSITIVE/NEGATIVE/NIL)	
BEGINNING NODE No. ps	
X-DIRECTIONAL ABSOLUTE COORDINATE OF NODE ps (LONGITUDE)	
Y-DIRECTIONAL ABSOLUTE COORDINATE OF NODE ps (LATITUDE)	
ABSOLUTE AZIMUTH OF NODE ps	
ps POSITION ERROR (m)	ps AZIMUTH ERROR (°)
MAXIMUM POSITION ERROR OF ENCODED SHAPE DATA (m)	MAXIMUM AZIMUTH ERROR OF ENCODED SHAPE DATA (°)
THE FOLLOWING INFORMATION IS ALSO ADDED TO ENCODED SHAPE DATA • REFERENCE NODE SETTING CODE • BLOCK LENGTH CHANGE CODE • EOD CODE	

END NODE No. pe	
X-DIRECTIONAL ABSOLUTE COORDINATE OF NODE pe (LONGITUDE)	
Y-DIRECTIONAL ABSOLUTE COORDINATE OF NODE pe (LATITUDE)	
ABSOLUTE AZIMUTH OF NODE pe	
pe POSITION ERROR (m)	pe AZIMUTH ERROR (°)
~	
SHAPE DATA IDENTIFICATION NUMBER = M	
~	

(b) TRAFFIC INFORMATION

HEADER INFORMATION		
THE NUMBER OF TRAFFIC INFORMATION PROVISION SECTIONS V		
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1		
REFERENCE SHAPE VECTOR STRING NUMBER = N		
DIRECTION IDENTIFICATION FLAG (POSITIVE/NEGATIVE)		
BEGINNING REFERENCE NODE Pa	END REFERENCE NODE Pb	
IDENTIFICATION CODE OF QUANTIZED BLOCK LENGTH IN THE DIRECTION OF DISTANCE		
IDENTIFICATION CODE OF TRAFFIC INFORMATION QUANTIZATION TABLE		
THE CURRENT INFORMATION: IDENTIFICATION CODE OF ENCODING TABLE		
PREDICTION INFORMATION: IDENTIFICATION CODE OF ENCODING TABLE		*
THE NUMBER OF QUANTIZED UNIT SECTIONS		
THE NUMBER OF TIME ZONE OF PREDICTION INFORMATION Q		*
VALID TIME OF THE CURRENT INFORMATION (HH : MM)		*
TRAFFIC INFORMATION OF THE BEGINNING (INITIAL VALUE)		
THE CURRENT TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE OBTAINED BY COMPARING ADJACENT POINT		
VALID TIME ZONE OF PREDICTION INFORMATION 1 (HH : MM ~ HH : MM)		*
PREDICTION TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE OBTAINED BY COMPARING ADJACENT POINT AND DIFFERENCE OF PRECEDING TIME ZONE		*
~		
VALID TIME ZONE OF PREDICTION INFORMATION Q (HH : MM ~ HH : MM)		*
PREDICTION TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE OBTAINED BY COMPARING ADJACENT POINT AND DIFFERENCE OF PRECEDING TIME ZONE		*
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = 2		
~		

[Fig. 21]

ORIGINAL

TIME, FUTURE, NOW

DISTANCE

EXAMPLE OF COARSENESS OF QUANTIZATION IN ACCORDANCE WITH FUTURE TIME (THE NUMBER OF POSITION/STATE)

POSITION RESOLUTION = 1/4, POSITION RESOLUTION = 1/2, POSITION RESOLUTION = STANDARD

DISTANCE

INFORMATION RESOLUTION = 2 STATE, INFORMATION RESOLUTION = 3 STATE

[Fig. 22]

0. ORIGINAL TRAFFIC INFORMATION (THE CURRENT MEASUREMENT VALUE + PREDICTION INFORMATION OF THE NEXT TIME ZONE)

PREDICTION INFORMATION OF THE NEXT TIME ZONE (PREDICTION 1)

THE CURRENT INFORMATION (NOW)

1. DIVIDE POSITION RESOLUTION INTO HALF (IN TRAFFIC INFORMATION, AVERAGE VALUE IS OBTAINED BY ROUNDING OFF FRACTIONS)
2. QUANTIZATION BY USING DETAILED QUANTIZATION TABLE
3. QUANTIZATION BY USING COARSE QUANTIZATION TABLE
4. EXTRACT DIFFERENCE IN TIME DIRECTION BY USING COARSE QUANTIZATION TABLE
5. EXTRACT DIFFERENCE FROM UPSTREAM SIDE BY USING EACH QUANTIZATION TABLE

[Fig. 23]

TRAFFIC INFORMATION QUANTIZATION TABLE (SPEED QUANTIZATION TABLE)

<table>
<tr><th>SPEED (km/h)</th><th>QUANTIZED VOLUME (NOW)</th><th>QUANTIZED VOLUME (PREDICTION 1)</th><th>QUANTIZED VOLUME (PREDICTION 2)</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td rowspan="2">1</td><td rowspan="4">1</td></tr>
<tr><td>2</td><td>2</td></tr>
<tr><td>3</td><td>3</td><td rowspan="2">2</td></tr>
<tr><td>4</td><td>4</td></tr>
<tr><td>5</td><td>5</td><td rowspan="2">3</td><td rowspan="4">2</td></tr>
<tr><td>6</td><td>6</td></tr>
<tr><td>7</td><td>7</td><td rowspan="2">4</td></tr>
<tr><td>8</td><td>8</td></tr>
<tr><td>9</td><td>9</td><td rowspan="2">5</td><td rowspan="3">3</td></tr>
<tr><td>10~11</td><td>10</td></tr>
<tr><td>12~13</td><td>11</td><td>6</td></tr>
</table>

14~15	12		
16~17	13	7	4
18~19	14		
20~24	15	8	
25~29	16		
30~34	17	9	5
35~39	18		
40~44	19	10	
45~49	20		
50~59	21	11	6
60~69	22		
70~79	23	12	
80~99	24		
~			
200 OR MORE	30	15	8 (180 km/h OR MORE)

[Fig. 24]

TRAFFIC INFORMATION

<table>
<tr><td colspan="2">HEADER INFORMATION</td></tr>
<tr><td colspan="2">THE NUMBER OF TRAFFIC INFORMATION PROVISION SECTIONS V</td></tr>
<tr><td colspan="2">TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1</td></tr>
<tr><td colspan="2">REFERENCE SHAPE VECTOR STRING NUMBER = N</td></tr>
<tr><td colspan="2">DIRECTION IDENTIFICATION FLAG (POSITIVE/NEGATIVE)</td></tr>
<tr><td>BEGINNING REFERENCE NODE Pa</td><td>END REFERENCE NODE Pb</td></tr>
<tr><td colspan="2">IDENTIFICATION CODE OF QUANTIZED BLOCK LENGTH IN THE DIRECTION OF DISTANCE</td></tr>
<tr><td colspan="2">IDENTIFICATION CODE OF TRAFFIC INFORMATION QUANTIZATION TABLE</td></tr>
<tr><td colspan="2">THE CURRENT INFORMATION: IDENTIFICATION CODE OF ENCODING TABLE</td></tr>
<tr><td colspan="2">PREDICTION INFORMATION: IDENTIFICATION CODE OF ENCODING TABLE</td></tr>
<tr><td colspan="2">THE NUMBER OF QUANTIZED UNIT SECTIONS</td></tr>
<tr><td colspan="2">THE NUMBER OF TIME ZONE OF PREDICTION INFORMATION Q</td></tr>
<tr><td colspan="2">VALID TIME OF THE CURRENT INFORMATION (HH : MM)</td></tr>
<tr><td colspan="2">TRAFFIC INFORMATION OF THE BEGINNING (INITIAL VALUE)</td></tr>
<tr><td colspan="2">THE CURRENT TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE</td></tr>
<tr><td colspan="2">VALID TIME ZONE OF PREDICTION INFORMATION 1 (HH : MM ~ HH : MM)</td></tr>
<tr><td>POSITION RESOLUTION IDENTIFICATION CODE</td><td>QUANTIZATION TABLE NUMBER</td></tr>
<tr><td colspan="2">THE CURRENT TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE</td></tr>
</table>

*

~	
VALID TIME ZONE OF PREDICTION INFORMATION Q (HH : MM ~ HH : MM)	
POSITION RESOLUTION IDENTIFICATION CODE	QUANTIZATION TABLE NUMBER
THE CURRENT TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE	
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = 2	
~	

*

[Fig. 25]

STATISTICAL PREDICTION VALUE OF ● = a(1) + b(2) + c(3) (WHERE, a + b + c = 1), OR = ((1) + (3)) ÷ 2

[Fig. 26]

(1)

ORIGINAL TRAFFIC INFORMATION DATA	
SPEED INFORMATION	CONGESTION INFORMATION

(2)

FFT PROCESSING IN TRANSMITTER (ENCODER)	
IMAGINARY REPRESENTATION OF ORIGINAL DATA	FFT COEFFICIENT AFTER FFT PROCESSING

(3) (4)

QUANTIZATION TABLE	TRANSMISSION DATA	
	QUANTIZATION COEFFICIENT OF FFT REAL PART	QUANTIZATION COEFFICIENT OF FFT IMAGINARY PART

(5)

INVERSE FFT PROCESSING IN RECEIVER (DECODER)	
IMAGINARY REPRESENTATION OF RECEIVED DATA	INVERSE FFT COEFFICIENT AFTER INVERSE FFT PROCESSING

(6)

REPRODUCED TRAFFIC INFORMATION DATA	
SPEED INFORMATION	CONGESTION INFORMATION

(7)

DIFFERENCE BETWEEN ORIGINAL AND REPRODUCED DATA

SPEED INFORMATION	CONGESTION INFORMATION

[Fig. 27]

(1)

ORIGINAL TRAFFIC INFORMATION DATA	
SPEED INFORMATION	CONGESTION INFORMATION

(2)

FFT PROCESSING IN TRANSMITTER (ENCODER)	
IMAGINARY REPRESENTATION OF ORIGINAL DATA	FFT COEFFICIENT AFTER FFT PROCESSING

(3) (4)

QUANTIZATION TABLE	TRANSMISSION DATA	
	QUANTIZATION COEFFICIENT OF FFT REAL PART	QUANTIZATION COEFFICIENT OF FFT IMAGINARY PART

(5)

INVERSE FFT PROCESSING IN RECEIVER (DECODER)	
IMAGINARY REPRESENTATION OF RECEIVED DATA	INVERSE FFT COEFFICIENT AFTER INVERSE FFT PROCESSING

(6)

REPRODUCED TRAFFIC INFORMATION DATA	
SPEED INFORMATION	CONGESTION INFORMATION

(7)

DIFFERENCE BETWEEN ORIGINAL AND REPRODUCED DATA	
SPEED INFORMATION	CONGESTION INFORMATION

[Fig. 28]

ENCODING TABLE CREATING UNIT

START

SUMMARIZE TRAFFIC INFORMATION OF PAST TRAFFIC SITUATION OF PATTERN L

SET QUANTIZATION-UNIT M IN THE DIRECTION OF DISTANCE

SET TRAFFIC INFORMATION QUANTIZATION TABLE N

St. 204: PERFORM FOURIER TRANSFORM (FFT)

St. 205: QUANTIZE FFT COEFFICIENTS AND CALCULATE QUANTIZATION

COEFFICIENTS

St. 206: CALCULATE DISTRIBUTION OF QUANTIZATION COEFFICIENTS

St. 207: CALCULATE DISTRIBUTION OF RUN LENGTHS

St. 208: CREATE ENCODING TABLE BASED ON DISTRIBUTION OF STATISTICAL PREDICTION DIFFERENCE VALUES AND RUN LENGTHS

COMPLETE ENCODING TABLE FOR CASE L-M-N

ARE ALL CASES OF L-M-N COMPLETE?

END

TRAFFIC INFORMATION TRANSMITTER

START

COLLECT TRAFFIC INFORMATION AND DETERMINE TRAFFIC INFORMATION PROVISION SECTION

TRAFFIC INFORMATION PROVISION SECTION V = 1

GENERATE SHAPE VECTOR AROUND TRAFFIC INFORMATION PROVISION SECTION V AND SET REFERENCE NODE

PERFORM IRREVERSIBLE COMPRESSION OF SHAPE VECTOR

DETERMINE TRAFFIC SITUATION AND DETERMINE QUANTIZATION LEVEL

PERFORM SAMPLING IN THE DIRECTION OF DISTANCE

CALCULATES TRAFFIC INFORMATION PER QUANTIZATION-UNIT

PERFORM PREPROCESSING OF TRAFFIC INFORMATION

St. 218: PERFORM QUANTIZATION OF TRAFFIC INFORMATION (LEVEL ALIGNMENT)

St. 219: TRANSFORM QUANTIZED TRAFFIC INFORMATION TO FOURIER COEFFICIENT

St. 220: EXECUTE VARIABLE LENGTH ENCODING/COMPRESSION OF FOURIER COEFFICIENT BY USING ENCODING TABLE

CORRECT UNIT BLOCK LENGTH (OR EACH THEREOF)

V = V + 1

IS THIS PROCESSING EXECUTED FOR ALL TRAFFIC INFORMATION PROVISION SECTION V?

CONVERT ENCODED DATA TO TRANSMISSION DATA

TRANSMIT DATA TOGETHER WITH THE ENCODING TABLE

END

INFORMATION RECEIVER

START

RECEIVE DATA

TRAFFIC INFORMATION PROVISION SECTION V = 1

DECODE SHAPE VECTOR AND PERFORM MAP MATCHING TO IDENTIFY THE TARGET ROAD SECTION

CORRECT UNIT BLOCK LENGTH (OR EACH THEREOF)

St. 234: DECODE TRAFFIC INFORMATION REFERRING TO ENCODING TABLE BY PERFORMING INVERSE FOURIER TRANSFORM

REFLECT DECODED TRAVEL TIME OF UNIT BLOCK (OR EACH THEREOF) ON LOCAL SYSTEM (LINK COST REFLECTION AND THE LIKE)

V = V + 1

IS THIS PROCESSING EXECUTED FOR ALL TRAFFIC INFORMATION PROVISION SECTION V

UTILIZE PROVIDED TRAVEL TIME TO EXECUTE APPLICATION PROCESS (REQUIRED TIME DISPLAY AND ROUTE GUIDANCE)

END

[Fig. 29]

EXAMPLE OF TRAFFIC INFORMATION REPRESENTED BY FFT

HEADER INFORMATION	
THE NUMBER OF TRAFFIC INFORMATION PROVISION SECTIONS V	
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1	
REFERENCE SHAPE VECTOR STRING NUMBER = N	
DIRECTION IDENTIFICATION FLAG (POSITIVE/NEGATIVE)	
BEGINNING REFERENCE NODE Pa	END REFERENCE NODE Pb
IDENTIFICATION CODE OF TRAFFIC INFORMATION QUANTIZATION TABLE	
IDENTIFICATION CODE OF ENCODING TABLE	
THE NUMBER OF BLOCK SPLITTING BETWEEN REFERENCE NODES 2^N	
DATA STRING IN WHICH VARIABLE LENGTH ENCODING IS PERFORMED ON FOURIER COEFFICIENT IN THE ORDER FROM LOW-FREQUENCY COMPONENT COEFFICIENT TO HIGH-FREQUENCY COMPONENT COEFFICIENT AND IN THE ORDER FROM REAL PART TO IMAGINARY PART	
~	
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = W	
~	

[Fig. 30]

EXEMPLARY ENCODING TABLE OF FFT COEFFICIENT

SPECIAL CODE		CODE	OVERHEAD BIT	
EOD CODE		1100	NIL	
ENCODING TABLE		CODE	OVERHEAD BIT I	OVERHEAD BIT II (RANGE)
RUN LENGTH	FFT COEFFICIENT			
0	0	0	0	-
5	0	100	0	-
10	0	1101	0	-
0	±1	1110	1 (±	0

			IDENTIFICATION)	
0	±2	111100	1 (± IDENTIFICATION)	0
0	±3~6	111101	1 (± IDENTIFICATION)	2 (IDENTIFICATION OF 3/4/5/6)
~				

[Fig. 31]

EXAMPLE 2 OF TRAFFIC INFORMATION REPRESENTED BY FFT (WHEN LOW-FREQUENCY COMPONENT AND HIGH-FREQUENCY COMPONENT IS SPLIT)

(a) BASIC INFORMATION AND FFT COEFFICIENT INFORMATION OF LOW-FREQUENCY COMPONENT

HEADER INFORMATION	
THE CURRENT INFORMATION NUMBER	THE NUMBER OF SPLITTING TRAFFIC INFORMATION
THE NUMBER OF TRAFFIC INFORMATION PROVISION SECTIONS V	
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1	
REFERENCE SHAPE VECTOR STRING NUMBER = N	
DIRECTION IDENTIFICATION FLAG (POSITIVE/NEGATIVE)	
BEGINNING REFERENCE NODE Pa	END REFERENCE NODE Pb
IDENTIFICATION CODE OF TRAFFIC INFORMATION QUANTIZATION TABLE	
IDENTIFICATION CODE OF ENCODING TABLE	
THE NUMBER OF BLOCK SPLITTING BETWEEN REFERENCE NODES 2^N	
DATA STRING IN WHICH VARIABLE LENGTH ENCODING IS PERFORMED ON FOURIER COEFFICIENT IN THE ORDER FROM LOW-FREQUENCY COMPONENT COEFFICIENT TO HIGH-FREQUENCY COMPONENT COEFFICIENT AND IN THE ORDER FROM REAL PART TO IMAGINARY PART	
~	
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = W	
~	

(b) FFT COEFFICIENT INFORMATION OF HIGH-FREQUENCY COMPONENT (A PART OF SPLIT INFORMATION)

HEADER INFORMATION	
THE CURRENT INFORMATION NUMBER □	THE NUMBER OF SPLITTING TRAFFIC INFORMATION □
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1	
DATA STRING IN WHICH VARIABLE LENGTH ENCODING IS PERFORMED ON FOURIER COEFFICIENT IN THE ORDER FROM LOW-FREQUENCY COMPONENT COEFFICIENT TO HIGH-FREQUENCY COMPONENT COEFFICIENT AND IN THE ORDER FROM REAL PART TO IMAGINARY PART	

~
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = W
~

[Fig. 32]

(a) NORMAL TRANSMISSION ORDER (TRANSMISSION IS SEQUENTIALLY PERFORMED IN THE RANGE FROM LOW-FREQUENCY COMPONENT TO HIGH-FREQUENCY COMPONENT SEQUENTIAL TRANSMISSION IN THE ORDER OF SECTION NUMBER)

INFORMATION OF SECTION NUMBER = 1 (FFT COEFFICIENT)		INFORMATION OF SECTION NUMBER = 2 (FFT COEFFICIENT)			INFORMATION OF SECTION NUMBER = V (FFT COEFFICIENT)	
REAL PART	IMAGINARY PART	REAL PART	IMAGINARY PART		REAL PART	IMAGINARY PART

(b) TRANSMISSION ORDER OF THIS SYSTEM (LOW-FREQUENCY COMPONENT OF ALL SECTIONS IS TRANSMITTED, AND SEQUENTIALLY, HIGH-FREQUENCY COMPONENT IS TRANSMITTED)

INFORMATION OF SECTION NUMBER = 1 (FFT COEFFICIENT)		INFORMATION OF SECTION NUMBER = 2 (FFT COEFFICIENT)			INFORMATION OF SECTION NUMBER = V (FFT COEFFICIENT)	
REAL PART	IMAGINARY PART	REAL PART	IMAGINARY PART		REAL PART	IMAGINARY PART

[Fig. 18]

EXEMPLARY SYSTEM CONFIGURATION
ENCODING TABLE CREATING UNIT
30: TRAFFIC INFORMATION TRANSMITTER
DIGITAL MAP DATABASE A
TRAFFIC INFORMATION QUANTIZATION TABLE (1)
ENCODING TABLE
QUANTIZATION-UNIT DETERMINATION UNIT
TRAFFIC INFORMATION COLLECTOR
TRAFFIC INFORMATION CONVERTER
FFT ENCODER
135: INFORMATION RECEIVER A
235: INFORMATION RECEIVER B
->: MEDIA A
->: MEDIA B
60: RECEIVING PARTY APPARATUS (APPLICATION FOR CAR NAVIGATION AND THE LIKE)
161: INFORMATION RECEIVER A

261: INFORMATION RECEIVER B
FFT DECODER
MAP MATCHING & SECTION DETERMINATION UNIT
TRAFFIC INFORMATION REFLECTING UNIT
DIGITAL MAP DATABASE B
LINK COST TABLE
INFORMATION UTILIZATION UNIT (ROUTE CALCULATION, SCREEN DISPLAY, AND THE LIKE)
LOCAL VEHICLE POSITION DETERMINATION UNIT
GPS ANTENNA
GYROSCOPE
GUIDANCE APPARATUS
TRAFFIC INFORMATION COLLECTOR

[Fig. 34]

(a) BASE TRAFFIC INFORMATION

HEADER INFORMATION	
THE CURRENT INFORMATION NUMBER	THE NUMBER OF SPLITTING TRAFFIC INFORMATION
THE NUMBER OF TRAFFIC INFORMATION PROVISION SECTIONS V	
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1	
REFERENCE SHAPE VECTOR STRING NUMBER = N	
DIRECTION IDENTIFICATION FLAG (POSITIVE/NEGATIVE)	
BEGINNING REFERENCE NODE Pa	END REFERENCE NODE Pb
IDENTIFICATION CODE OF QUANTIZED BLOCK LENGTH IN THE DIRECTION OF DISTANCE	
IDENTIFICATION CODE OF TRAFFIC INFORMATION QUANTIZATION TABLE	
THE CURRENT INFORMATION: IDENTIFICATION CODE OF ENCODING TABLE	
PREDICTION INFORMATION: IDENTIFICATION CODE OF ENCODING TABLE	
THE NUMBER OF QUANTIZED UNIT SECTIONS	
THE NUMBER OF TIME ZONE OF PREDICTION INFORMATION Q	
VALID TIME OF THE CURRENT INFORMATION (HH : MM)	
TRAFFIC INFORMATION OF THE BEGINNING (INITIAL VALUE)	
THE CURRENT TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE OBTAINED BY COMPARING ADJACENT POINT	
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = 2	
~	

(b) INFORMATION OF DIFFERENCE FROM PRECEDING TIME ZONE INFORMATION

HEADER INFORMATION	
THE CURRENT INFORMATION NUMBER	THE NUMBER OF SPLITTING TRAFFIC

	INFORMATION
TRAFFIC INFORMATION PROVISION SECTION SERIAL No. 1	
ENCODING TABLE IDENTIFICATION CODE	
VALID TIME ZONE OF PREDICTION INFORMATION Q (HH : MM ~ HH : MM)	
THE CURRENT TRAFFIC INFORMATION ENCODED BY STATISTICAL PREDICTION DIFFERENCE VALUE OBTAINED BY COMPARING ADJACENT POINT AND DIFFERENCE OF PRECEDING TIME ZONE	
TRAFFIC INFORMATION PROVISION SECTION SERIAL NUMBER = 2	
~	

[Fig. 35]

EXEMPLARY SYSTEM CONFIGURATION (APPLICATION FOR PC, OPERATION SYSTEM, AND THE LIKE)

330: TRAFFIC INFORMATION CONVERTER/RECORDER

DIGITAL MAP DATABASE A

TRAFFIC INFORMATION QUANTIZATION TABLE (1)

ENCODING TABLE

QUANTIZATION-UNIT DETERMINATION UNIT (□2)

TRAFFIC INFORMATION AND PREDICTION INFORMATION COLLECTOR

TRAFFIC INFORMATION CONVERTER

34: ENCODER

335: INFORMATION ACCUMULATING UNIT

331: INTERNAL STORAGE MEDIA

332: EXTERNAL STORAGE MEDIA

ENCODING TABLE CREATING UNIT

TRAFFIC INFORMATION COLLECTOR

360: TRAFFIC INFORMATION REFERENCE/UTILIZATION APPARATUS

361: INTERNAL STORAGE MEDIA

332: EXTERNAL STORAGE MEDIA

362: DECODER

MAP MATCHING & SECTION DETERMINATION UNIT

TRAFFIC INFORMATION REFLECTING UNIT

DIGITAL MAP DATABASE B

LINK COST TABLE

INFORMATION UTILIZATION UNIT (ROUTE CALCULATION, GUIDANCE, SCREEN DISPLAY, AND THE LIKE)

[Fig. 36]

SERVER (TRAFFIC INFORMATION PROVISION SYSTEM)

<-: REQUEST INFORMATION (REQUIRED TRAFFIC INFORMATION RANGE)

->: RESPONSE INFORMATION (TRAFFIC INFORMATION RESPONDING TO REQUEST)

CLIENT (TRAFFIC INFORMATION DISPLAY AND UTILIZATION)

[Fig. 37]

CLIENT TO SERVER TRANSMISSION INFORMATION <REQUEST INFORMATION>

HEADER INFORMATION (USER ID AND THE LIKE)
DESIRED MAXIMUM DATA SIZE □1
LATITUDE/LONGITUDE OF LOWER LEFT/UPPER RIGHT OF RECTANGLE □2
CENTER POINT □2
PREFECTURAL/COMMUNAL CODE □2
ROAD SPECIFICATION (ROAD ATTRIBUTES AND THE LIKE) □3
LATITUDE/LONGITUDE OF BEGINNING/END FOR PATH SEARCH REQUEST □3
LATITUDE/LONGITUDE OF CURRENT POSITION + TRAVEL DIRECTION

[Fig. 38]

SERVER (REQUEST INFORMATION RECEIVER AND TRAFFIC INFORMATION TRANSMITTER)

START

St. 300: WAIT REQUEST FROM CLIENT

St. 301: RECEIVE REQUEST INFORMATION FROM CLIENT

St. 302: DETERMINE DETAIL LEVEL OF TRAFFIC INFORMATION TO TRANSMIT TO CLIENT FROM REQUEST INFORMATION

St. 303: PERFORM QUANTIZATION AND ENCODING OF TRAFFIC INFORMATION

St. 304: TRANSMIT ENCODED TRAFFIC INFORMATION AND ENCODING TABLE TO CLIENT

CLIENT APPARATUS

START

St. 310: DETERMINE RANGE AND DESIRED DATA SIZE OF TRAFFIC INFORMATION NECESSARY FOR DISPLAY OR PATH SEARCH

St. 311: TRANSMIT REQUEST TO SERVER

St. 312: RECEIVE RESPONSE INFORMATION FROM THE SERVER

St. 313: DECODE TRAFFIC INFORMATION REPRESENTED BY CODE BY REFERRING TO ENCODING TABLE

St. 314: PERFORM MAP MATCHING BASED ON POSITION INFORMATION (SUCH AS SHAPE VECTOR), AND SPECIFY POSITION OF RECEIVED TRAFFIC INFORMATION

St. 315: UTILIZING TRAFFIC INFORMATION (SUCH AS MAP SUPERPOSITION DISPLAY AND PATH SEARCH)

END

[Fig. 39]

TRAFFIC INFORMATION COLLECTOR

ENCODING TABLE CREATING UNIT

430: SERVER (REQUEST INFORMATION RECEIVER AND TRAFFIC INFORMATION TRANSMITTER)

431: REQUEST INFORMATION RECEIVER

432: TRANSMIT TRAFFIC INFORMATION AREA/DETAIL LEVEL DETERMINATION UNIT

433: TRAFFIC INFORMATION DATA (ORIGINAL MANAGEMENT INFORMATION)

434: ENCODING TABLE DATA

435: TRAFFIC INFORMATION QUANTIZATION/CODING UNIT

436: RESPONSE INFORMATION TRANSMITTER

460: CLIENT APPARATUS

461: REQUEST INFORMATION TRANSMITTER

462: DISPLAY RANGE/DATA SIZE DETERMINATION UNIT

463: INPUT OPERATION SECTION

464: RESPONSE INFORMATION RECEIVER

465: DECODER

466: TRAFFIC INFORMATION UTILIZATION UNIT

467: DIGITAL MAP DATABASE

[Fig. 40]

• : REFERENCE NODE

• : REFERENCE NODE

• : REFERENCE NODE

ROAD SHAPE OF SHAPE VECTOR

ROAD SHAPE OF MAP DATA STORED IN RECEIVER (TRAFFIC INFORMATION UTILIZATION UNIT)

REFERENCE NODE POSITION AFTER TARGET ROAD DETERMINATION (AFTER MAP MATCHING)

[Fig. 41]

LINK A 30 MINUTES

LINK B 23 MINUTES

CONGESTION 500 m

[Fig. 42]

↑: DETAIL

•-•: TRAVEL TIME (WHICH IS FIXED AS LINK UNIT)

TRAFFIC REPRESENTATION RESOLUTION (THE NUMBER OF REPRESENTABLE STATES)

↑→: COARSE

POSITION (OR SECTION) RESOLUTION

•: CONGESTION INFORMATION
→: DETAIL

[Fig. 43]

THE CURRENT LINK SYSTEM

↑: DATA VOLUME OF TRAFFIC INFORMATION
TRANSMISSION PATH CAPACITY
DATA IN THIS PART IS LOST
→: TIME

IDEAL SYSTEM

↑: DATA VOLUME OF TRAFFIC INFORMATION
DANGER REGION
DATA IN EXCESS BE NOT LOST IN DANGER REGION AND RESOLUTION OF DATA BE MADE "COARSE" IN ASCENDING ORDER OF IMPORTANCE SO AS TO REDUCE OVERALL DATA VOLUME
TRANSMISSION PATH CAPACITY
→: TIME

[Fig. 42]

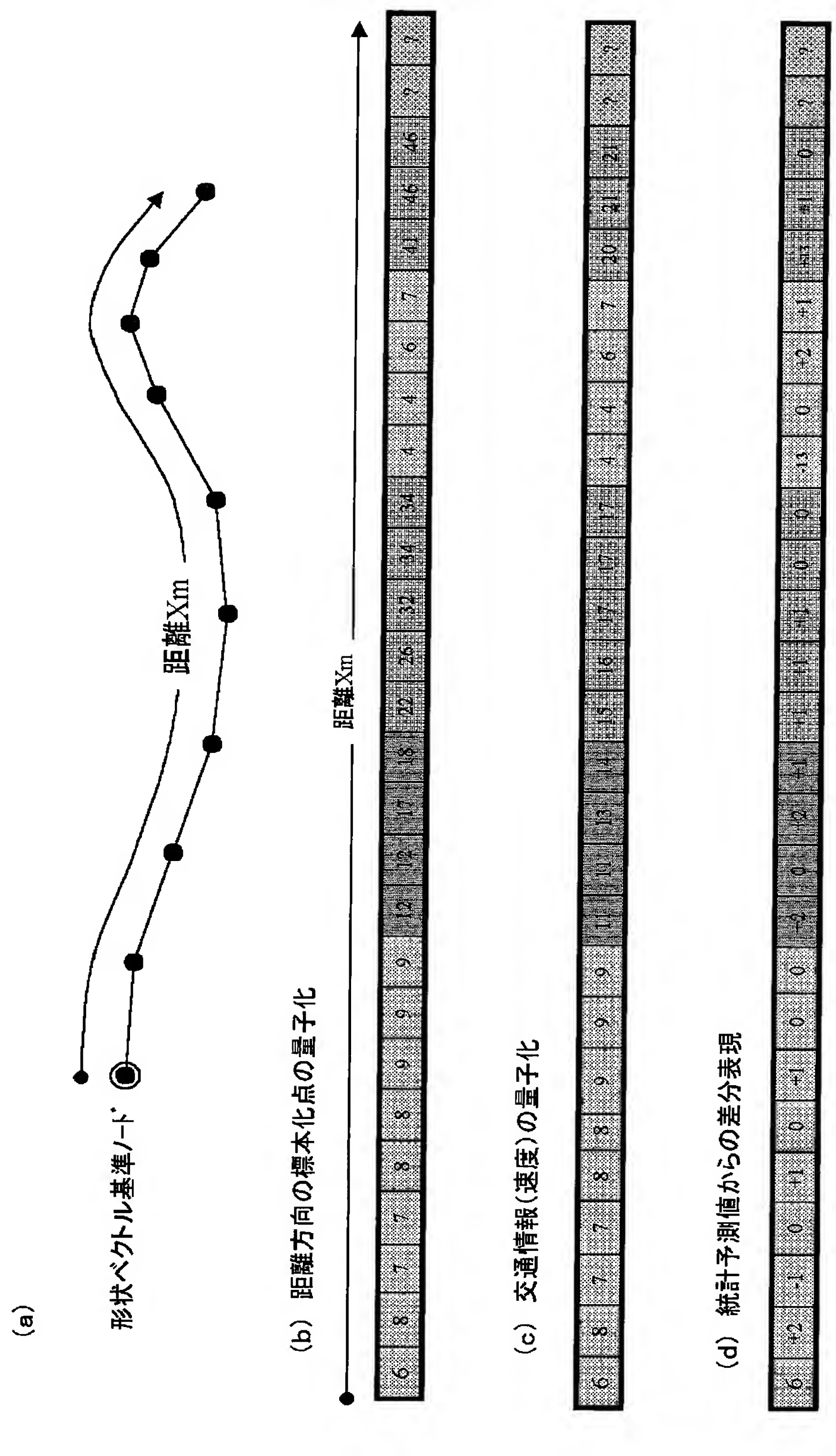
WHEN TRANSMISSION PATH CAPACITY IS LARGE ENOUGH

↑: DETAIL
TRAFFIC REPRESENTATION RESOLUTION (THE NUMBER OF REPRESENTABLE STATES)
TRAFFIC INFORMATION REPRESENTED BY HIGH POSITION RESOLUTION AND TRAFFIC REPRESENTATION RESOLUTION
↑→: COARSE
POSITION (OR SECTION) RESOLUTION
→: DETAIL

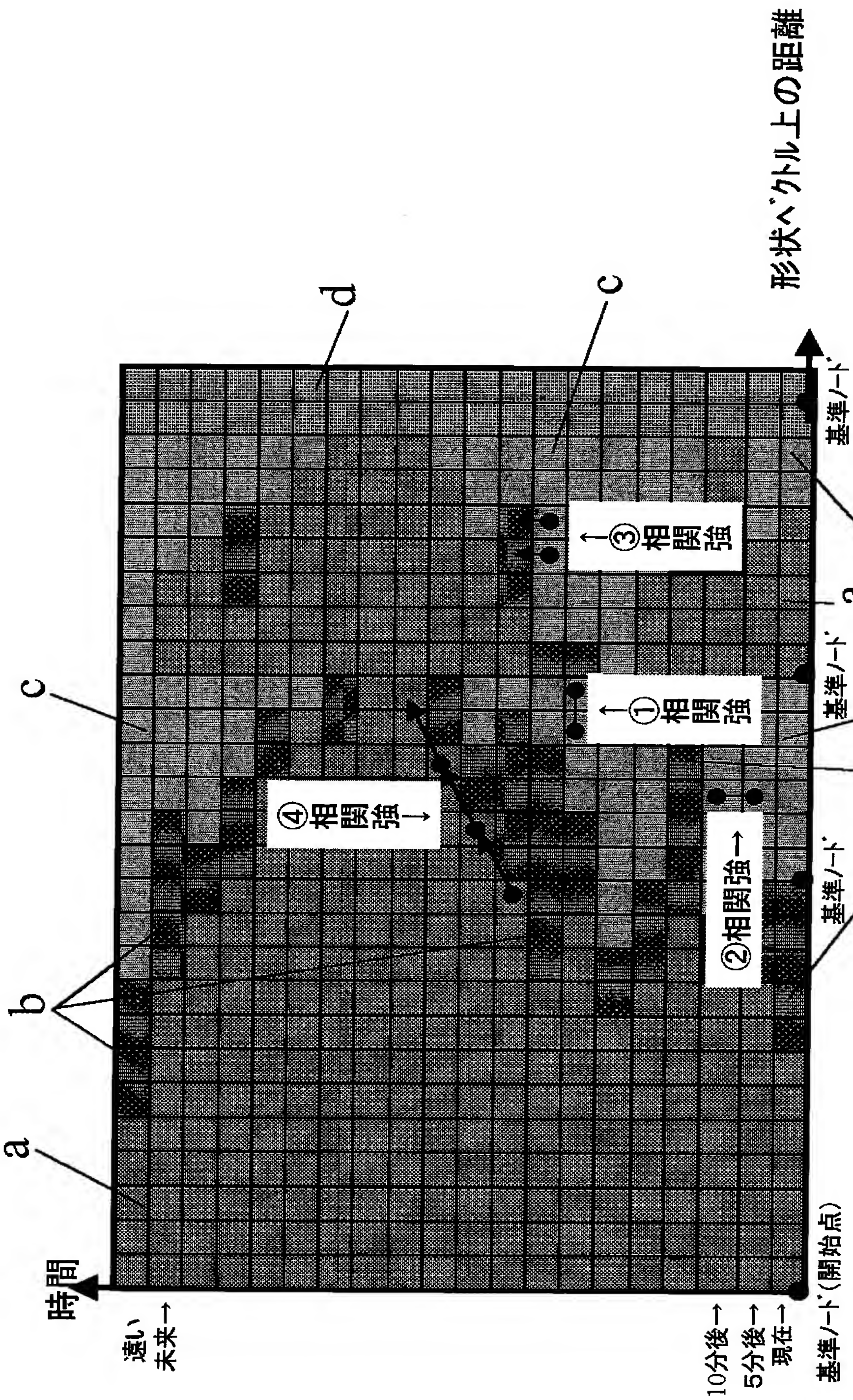
WHEN INFORMATION VOLUME HAS INCREASED NEAR TRANSMISSION PATH CAPACITY

↑: DETAIL
TRAFFIC REPRESENTATION RESOLUTION (THE NUMBER OF REPRESENTABLE STATES)
INFORMATION ON ROUTE WHOSE IMPORTANCE IS LOW
POSITION RESOLUTION IS REDUCED
RESOLUTION IN CLOSE ROUTE OF IMPORTANCE (THE CURRENT STATE IS MAINTAINED)
BOTH RESOLUTION ARE REDUCED
STATE NUMBER RESOLUTION IS REDUCED
PREDICTION INFORMATION OF DISTANT FUTURE
INFORMATION OF SIDE DISTANT FROM INFORMATION PROVISION POINT

【書類名】　図面
【図１】


(a)
形状ベクトル基準ノード
距離Xm
(b) 距離方向の標本化点の量子化
距離Xm
(c) 交通情報(速度)の量子化
(d) 統計予測値からの差分表現

【図２】



時間
遠い未来→
10分後→
5分後→
現在→
基準ノード(開始点)
基準ノード
基準ノード
基準ノード
形状ベクトル上の距離
①相関強→
②相関強→
③相関強→
④相関強→
a
b
c
d

【図３】

交通情報量子化テーブル（速度量子化テーブル）

量子化量	速度（km/h）
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10～11
11	12～13
12	14～15
13	16～17
14	18～19
15	20～24
16	25～29
17	30～34
18	35～39
19	40～44
20	45～49
21	50～59
22	60～69
23	70～79
24	80～99
～	
30	200以上

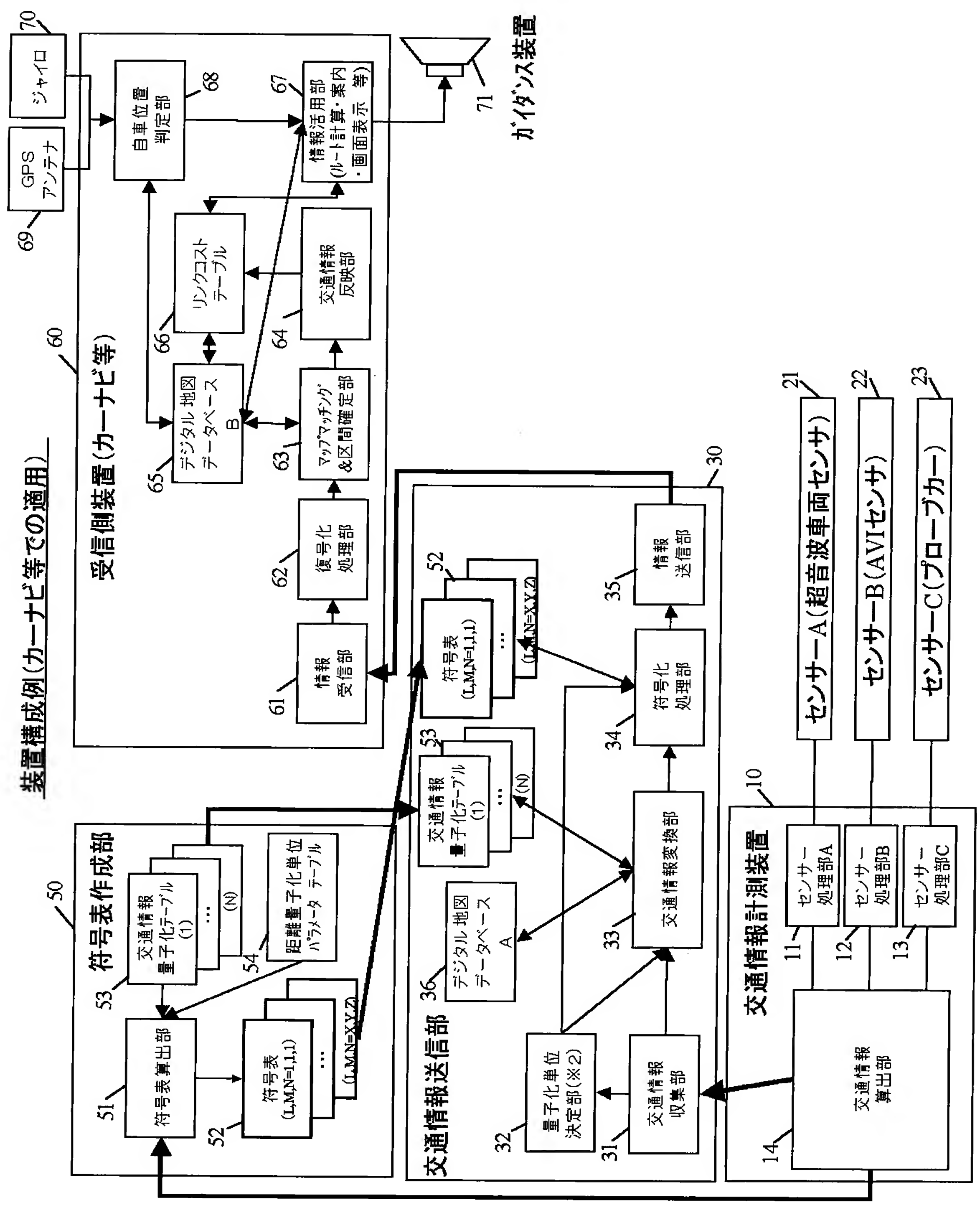
【図4】

交通情報の統計予測値差分の符号表例

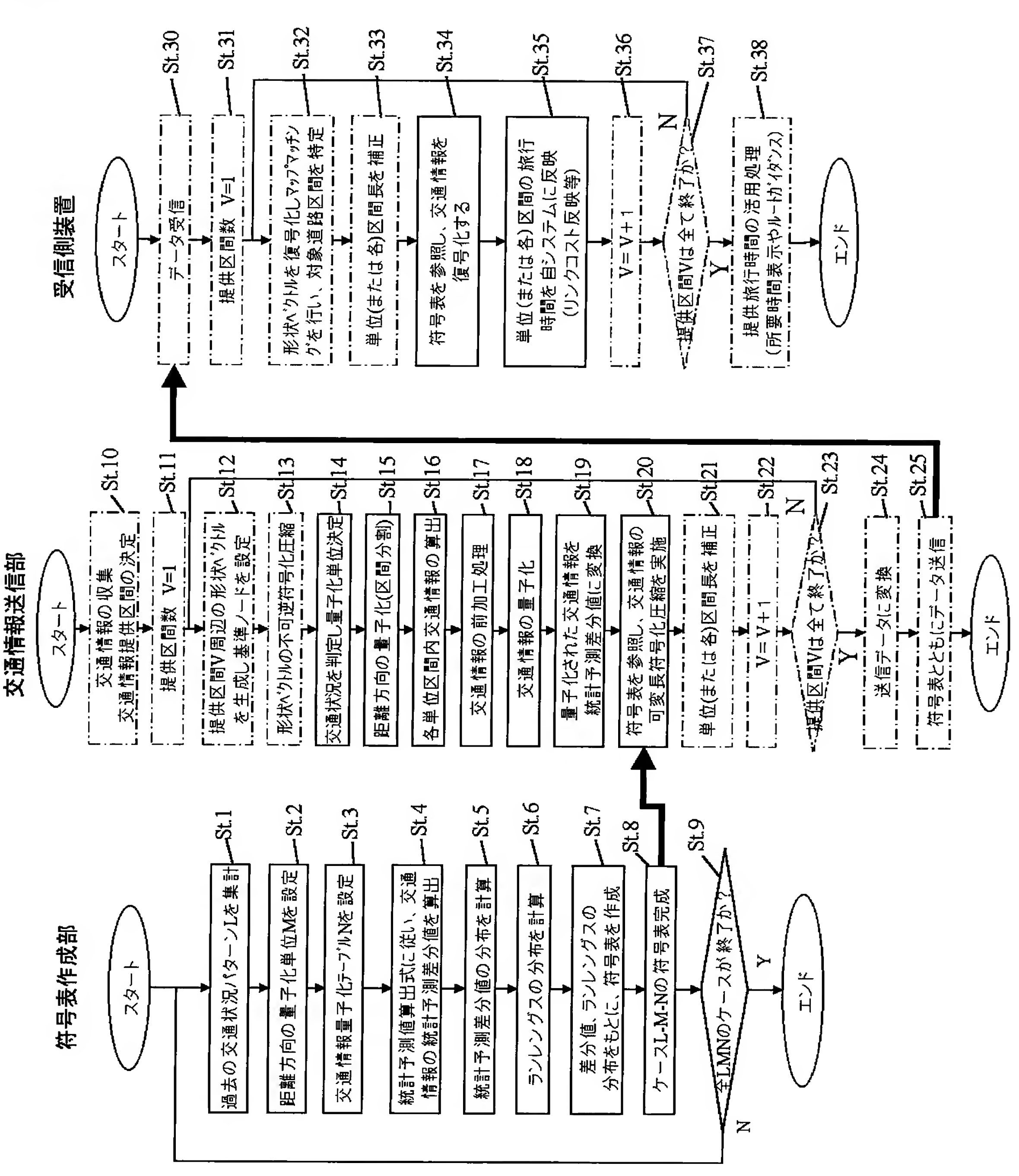
特殊コード	符号	付加ビット
区間長変更コード	101	3(40/80/160/･･･/5120m)
交通情報量子化テーブル変更コード	111110	4(テーブル番号)
基準ノード対応地点識別コード	1100	6(対応する基準ノード番号)+ 8(基準ノードからのオフセット距離)

交通情報の統計予測差分値符号表		符号	付加ビットⅠ	付加ビットⅡ(範囲)
ランレングス	変更量			
0	0	0	0	−
5	0	100	0	−
10	0	1101	0	−
0	±1	1110	1(±識別)	0
0	±2	111100	1(±識別)	0
0	±4	111101	1(±識別)	1(3 or 4)
		∫		

【図５】


装置構成例(カーナビ等での適用)
受信側装置(カーナビ等)
60
GPS アンテナ
69
ジャイロ
70
自車位置判定部
68
情報活用部(ルート計算・案内・画面表示 等)
67
71
ガイダンス装置
リンクコストテーブル
66
交通情報反映部
64
デジタル地図データベースB
65
マップマッチング&区間確定部
63
復号化処理部
62
情報受信部
61
符号表作成部
50
交通情報量子化テーブル(1)
…
(N)
53
距離量子化単位パラメータテーブル
54
符号表算出部
51
符号表(L,M,N=1,1,1)
…
(L,M,N=X,Y,Z)
52
交通情報送信部
30
情報送信部
35
符号化処理部
34
交通情報変換部
33
デジタル地図データベースA
36
量子化単位決定部(※2)
32
交通情報収集部
31
交通情報計測装置
10
センサー処理部A
11
センサー処理部B
12
センサー処理部C
13
交通情報算出部
14
センサーA(超音波車両センサ)
21
センサーB(AVIセンサ)
22
センサーC(プローブカー)
23

【図６】


符号表作成部
スタート
過去の交通状況パターンLを集計
St.1
距離方向の量子化単位Mを設定
St.2
交通情報量子化テーブルNを設定
St.3
統計予測値算出式に従い、交通情報の統計予測差分値を算出
St.4
統計予測差分値の分布を計算
St.5
ランレングスの分布を計算
St.6
差分値、ランレングスの分布をもとに、符号表を作成
St.7
ケースL-M-Nの符号表完成
St.8
全LMNのケースが終了か？
St.9
Y
N
エンド
交通情報送信部
スタート
交通情報の収集
交通情報提供区間の決定
St.10
提供区間数 V=1
St.11
提供区間V周辺の形状ベクトルを生成し基準ノードを設定
St.12
形状ベクトルの不可逆符号化圧縮
St.13
交通状況を判定し量子化単位決定
St.14
距離方向の量子化(区間分割)
St.15
各単位区間内交通情報の算出
St.16
交通情報の前加工処理
St.17
交通情報の量子化
St.18
量子化された交通情報を統計予測差分値に変換
St.19
符号表を参照し、交通情報の可変長符号化圧縮を実施
St.20
単位(または各)区間長を補正
St.21
V＝V＋1
St.22
提供区間Vは全て終了か？
St.23
N
Y
送信データに変換
St.24
符号表とともにデータ送信
St.25
エンド
受信側装置
スタート
データ受信
St.30
提供区間数 V=1
St.31
形状ベクトルを復号化しマップマッチングを行い、対象道路区間を特定
St.32
単位(または各)区間長を補正
St.33
符号表を参照し、交通情報を復号化する
St.34
単位(または各)区間の旅行時間を自システムに反映(リンクコスト反映等)
St.35
V＝V＋1
St.36
提供区間Vは全て終了か？
St.37
N
Y
提供旅行時間の活用処理(所要時間表示やルートガイダンス)
St.38
エンド

【図7】

(a)

地図データ構成例

管理情報（情報種別/区画定義等）	
ノード数N	
ノード番号1	
ノード1のノード属性情報	
ノード1の経度	ノード1の緯度
ノード1に接続するノード数	
接続ノード番号#1	リンク番号#1-1
～	
接続ノード番号#m	リンク番号#1-m
～～	
ノード番号N	
ノードNのノード属性情報	
ノードNの経度	ノードNの緯度
ノードNに接続するノード数	
接続ノード番号#1	リンク番号#N-1
～	
接続ノード番号#m	リンク番号#N-m
リンク数L	
リンク番号1	
リンク1のリンク属性情報	
リンク1の構成補間点数	
補間点1-1経度	補間点1-1緯度
～	
補間点1-p経度	補間点1-p緯度
～～	
リンク番号L	
リンクLのリンク属性情報	
リンクLの構成補間点数	
補間点L-1経度	補間点L-1緯度
～	
補間点L-p経度	補間点L-p緯度

(b)

交通情報データ例
（旅行時間/速度の例）

地図データリンク番号 1	
現在:旅行時間	現在:速度
5分後:旅行時間	5分後:速度
10分後:旅行時間	10分後:速度
～	
Z分後:旅行時間	Z分後:速度
～～	
地図データリンク番号 K	
現在:旅行時間	現在:速度
5分後:旅行時間	5分後:速度
10分後:旅行時間	10分後:速度
～	
Z分後:旅行時間	Z分後:速度
～～	

【図8】

(a)

形状ベクトルデータ列情報
（符号化圧縮データ）

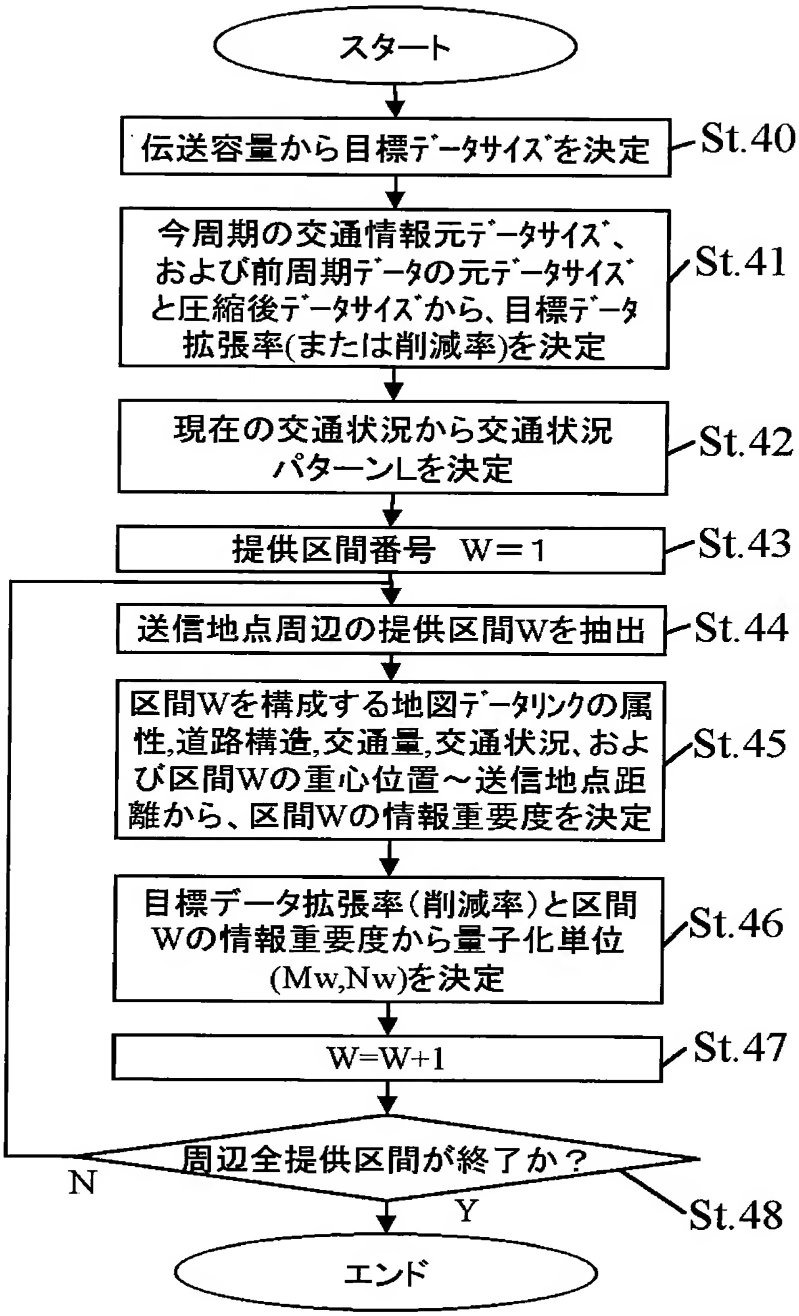
ヘッダ情報	
形状ベクトル数 N	
形状ベクトルデータ識別番号＝1	
符号表識別コード	
形状取得元 地図データ の精度情報	
一方通行方向(順/逆/無)	
始端ノード番号ps	
ノードpsX方向絶対座標(経度)	
ノードpsY方向絶対座標(緯度)	
ノードps絶対方位	
ps位置誤差(m)	ps方位誤差(°)
符号化形状データの最大位置誤差(m)	符号化形状データの最大方位誤差(°)
符号化された形状データ なお、次の情報も含む ・基準ノード設定コード ・区間長変更コード ・EODコード	
終端ノード番号pe	
ノードpeX方向相対座標(経度)	
ノードpeY方向相対座標(緯度)	
ノードpe絶対方位	
pe位置誤差(m)	pe方位誤差(°)
～	
形状ベクトルデータ識別番号＝M	
～	

(b)

交通情報

ヘッダ情報	
交通情報提供区間数 V	
交通情報提供区間シリアル番号 1	
参照形状ベクトル列番号＝N	
方向識別フラグ(順方向/逆方向)	
始端側基準ノードPa	終端側基準ノードPb
距離方向の量子化区間長識別コード	
交通情報量子化テーブル識別コード	
符号表識別コード	
量子化された単位区間の数	
始端の交通情報(初期値)	
統計予測値との差分値で符号化された交通情報。なお、次の情報も含む ・区間長変更コードおよび変更後の区間長 ・交通情報量子化テーブル変更コードおよび変更後のテーブル番号 ・基準ノード対応地点識別コードおよび対応する基準ノード番号＋オフセット距離	
～	
交通情報提供区間シリアル番号＝W	
～	

【図９】


スタート
伝送容量から目標データサイズを決定
St.40
今周期の交通情報元データサイズ、および前周期データの元データサイズと圧縮後データサイズから、目標データ拡張率(または削減率)を決定
St.41
現在の交通状況から交通状況パターンLを決定
St.42
提供区間番号　W＝１
St.43
送信地点周辺の提供区間Wを抽出
St.44
区間Wを構成する地図データリンクの属性,道路構造,交通量,交通状況、および区間Wの重心位置～送信地点距離から、区間Wの情報重要度を決定
St.45
目標データ拡張率（削減率）と区間Wの情報重要度から量子化単位(Mw,Nw)を決定
St.46
W=W+1
St.47
周辺全提供区間が終了か？
N
Y
St.48
エンド

【図１０】

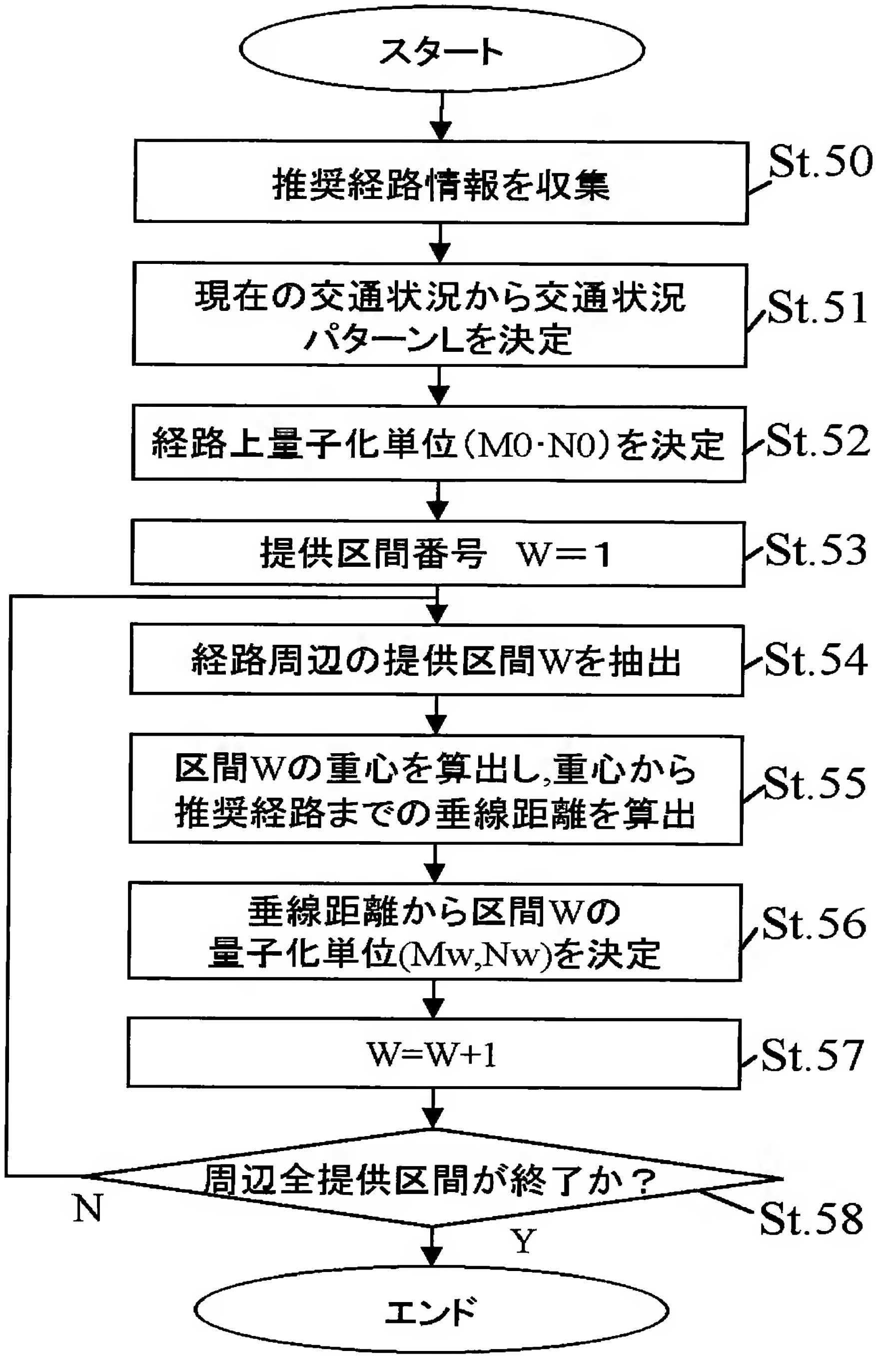
（a）

目標データ拡張率	情報重要度A	情報重要度B	情報重要度C	備　考
デフォルト	ランク2	ランク3	ランク4	—
2.0倍以上	＋1ランク	＋2ランク	＋3ランク	詳細化
1.6〜1.9倍	±0ランク	＋1ランク	＋2ランク	↑
1.1〜1.3倍	±0ランク	±0ランク	＋1ランク	↑
1.0倍	±0ランク	±0ランク	±0ランク	変更無し
0.7〜0.9倍	±0ランク	±0ランク	−1ランク	↓
0.6〜0.5倍	±0ランク	−1ランク	−2ランク	↓
0.4倍以下	−1ランク	−2ランク	−3ランク	概略化

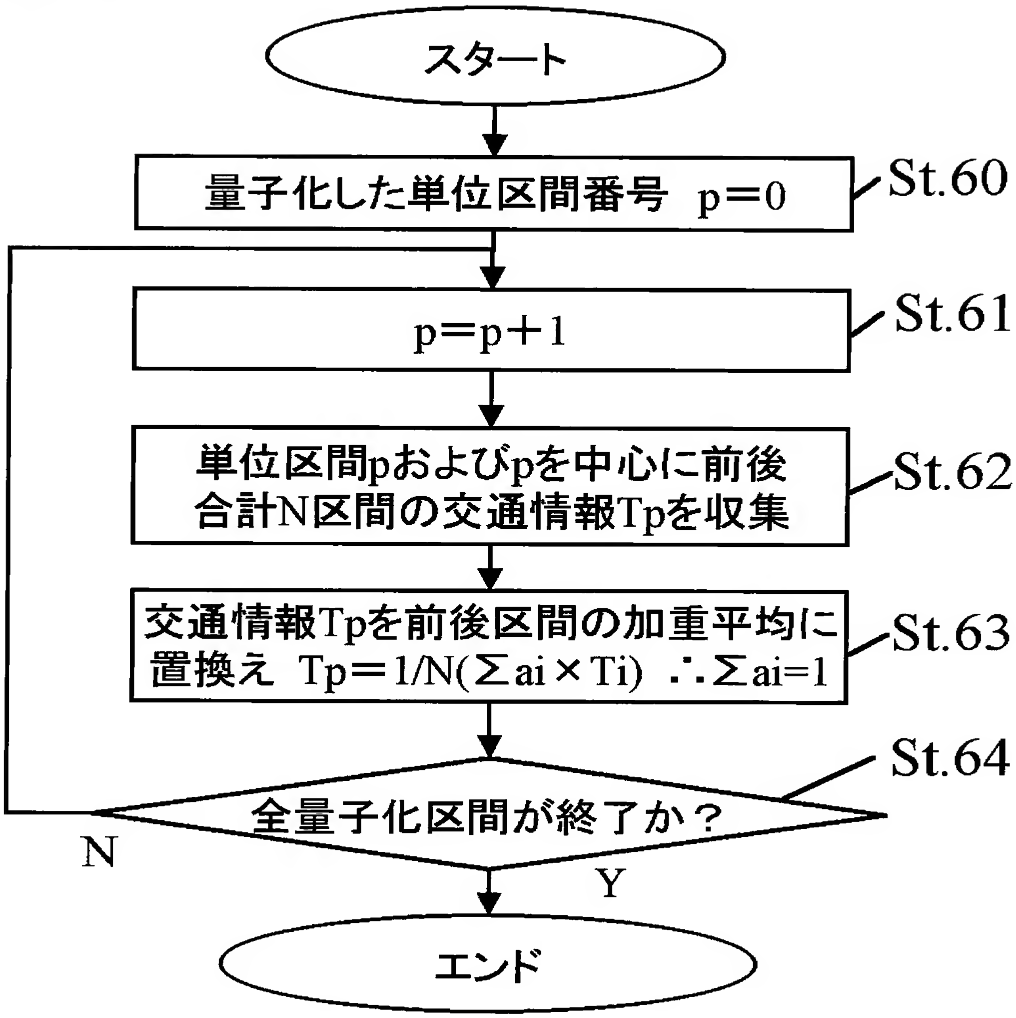
（b）

量子化単位ランク	距離方向量子化単位M	交通情報量子化テーブルN	詳細度
ランク1	50m	テーブル1	詳細
ランク2	100m	テーブル2	やや詳細
ランク3	150m	テーブル2	標準
ランク4	200m	テーブル3	やや粗い
ランク5	200m	テーブル4	粗い

【図１１】

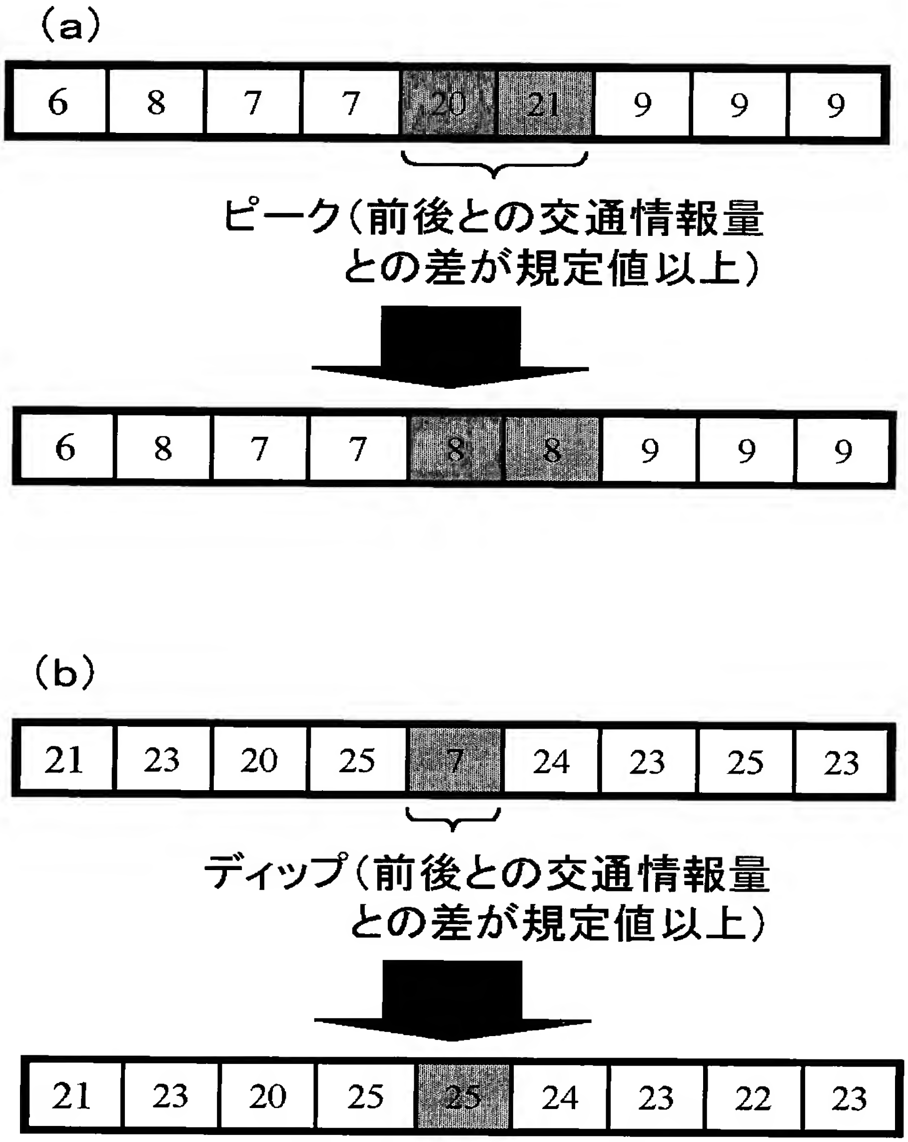

スタート
推奨経路情報を収集
St.50
現在の交通状況から交通状況
パターンLを決定
St.51
経路上量子化単位(M0·N0)を決定
St.52
提供区間番号　W＝1
St.53
経路周辺の提供区間Wを抽出
St.54
区間Wの重心を算出し,重心から
推奨経路までの垂線距離を算出
St.55
垂線距離から区間Wの
量子化単位(Mw,Nw)を決定
St.56
W=W+1
St.57
周辺全提供区間が終了か？
St.58
N
Y
エンド

【図１２】

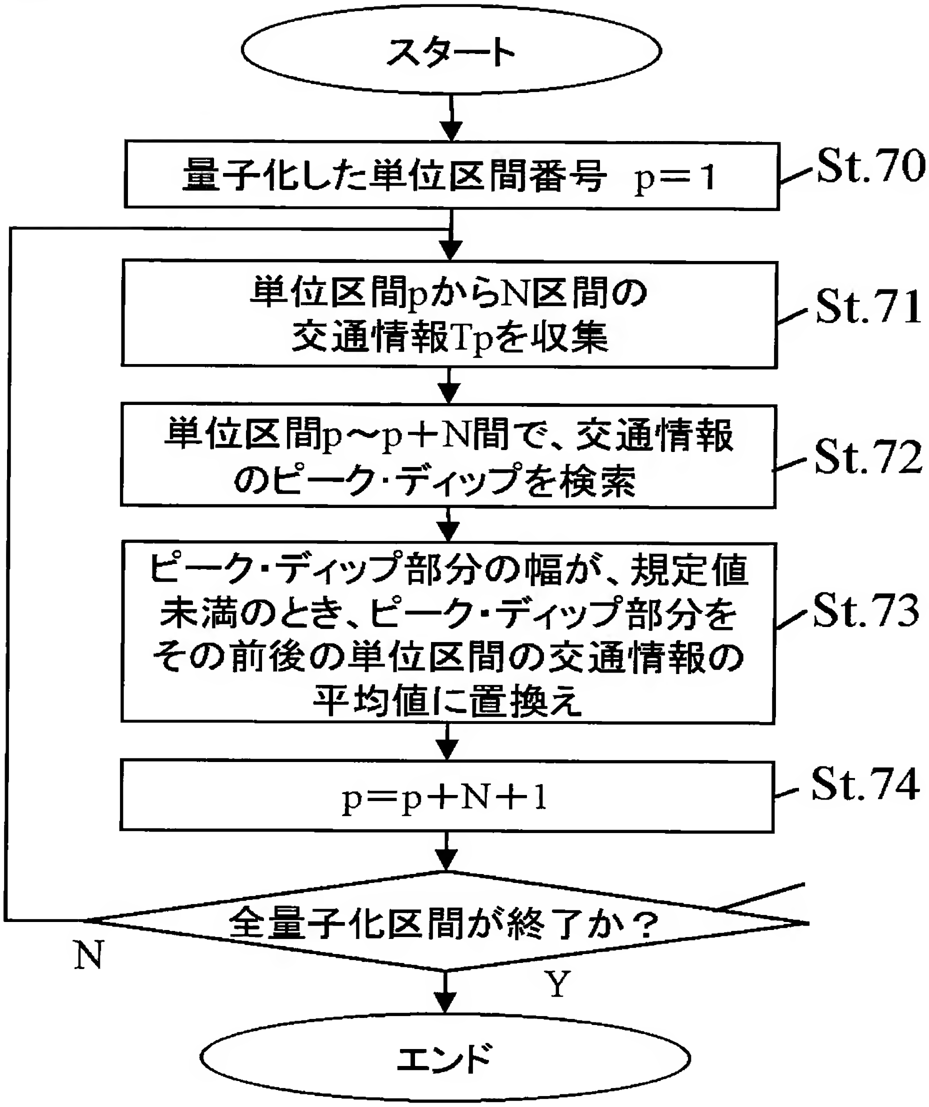


スタート
量子化した単位区間番号　p＝0
St.60
p＝p＋1
St.61
単位区間pおよびpを中心に前後
合計N区間の交通情報Tpを収集
St.62
交通情報Tpを前後区間の加重平均に
置換え　Tp＝1/N(Σai×Ti)　∴Σai=1
St.63
全量子化区間が終了か？
St.64
N
Y
エンド

【図１３】

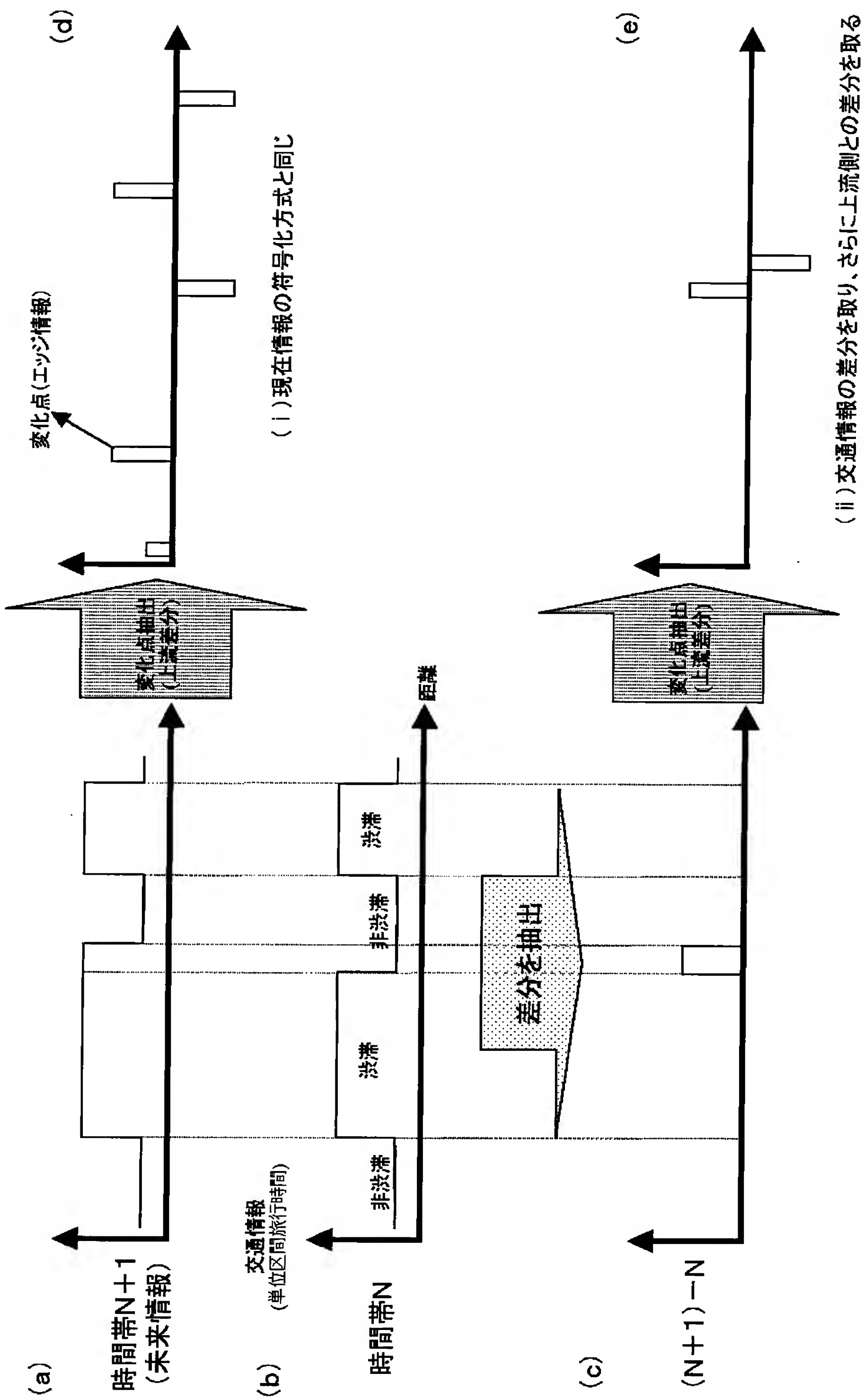

（a）
6
8
7
7
20
21
9
9
9
ピーク（前後との交通情報量
との差が規定値以上）
6
8
7
7
8
8
9
9
9
（b）
21
23
20
25
7
24
23
25
23
ディップ（前後との交通情報量
との差が規定値以上）
21
23
20
25
25
24
23
22
23

【図１４】



スタート
量子化した単位区間番号 p＝1
St.70
単位区間pからN区間の
交通情報Tpを収集
St.71
単位区間p～p＋N間で、交通情報
のピーク・ディップを検索
St.72
ピーク・ディップ部分の幅が、規定値
未満のとき、ピーク・ディップ部分を
その前後の単位区間の交通情報の
平均値に置換え
St.73
p＝p＋N＋1
St.74
全量子化区間が終了か？
N
Y
エンド

【図１５】


(a)
時間帯N＋1
（未来情報）
交通情報
（単位区間旅行時間）
距離
(b)
時間帯N
非渋滞
渋滞
非渋滞
渋滞
差分を抽出
(c)
(N＋1)－N
変化点抽出
（上流差分）
(d)
変化点（エッジ情報）
（ⅰ）現在情報の符号化方式と同じ
(e)
（ⅱ）交通情報の差分を取り、さらに上流側との差分を取る

【図１６】

（ⅱ）の計算例

(a)

1.元の交通情報（現在計測値＋次時間帯の予測情報）

次時間帯の予測情報⇒	7	6	7	6	9	8	5	7	6	7	9	8	6	7	5	36	42	35	6	5	6
現在情報⇒	6	8	7	7	8	8	9	9	9	12	12	17	18	22	26	32	34	34	4	4	6

(b)

2.交通情報の量子化表現

7	6	7	6	9	8	5	7	6	7	6	8	6	7	5	18	19	18	6	5	6
6	8	7	7	8	8	9	9	9	11	11	13	14	15	16	17	17	17	4	4	6

相関法則Bにより±0周辺に集中

(c)

3.予測情報を現在情報との差分で表現
（現在情報は隣接単位区画との差分で表現）

+1	-2	0	-1	+1	0	-4	-2	-3	-4	-5	-5	-8	-8	-11	0	-2	-1	+2	+1	0
6	+2	-1	0	+1	0	+1	0	0	+2	0	+2	+1	+1	+1	+1	0	0	-13	0	+2

相関法則Cにより±0周辺に集中

(d)

4.さらに予測情報を隣接単位区画との差分で表現

+1	-3	+2	-1	+2	-1	-4	-2	-1	-1	-1	0	-3	0	-3	+11	-2	-1	+3	-1	0
6	+2	-1	0	+1	0	+1	0	0	+2	0	+2	+1	+1	+1	+1	0	0	-13	0	+2

【図１７】

（a）

交通情報の統計予測値差分の符号表例（前述のものに同じ）

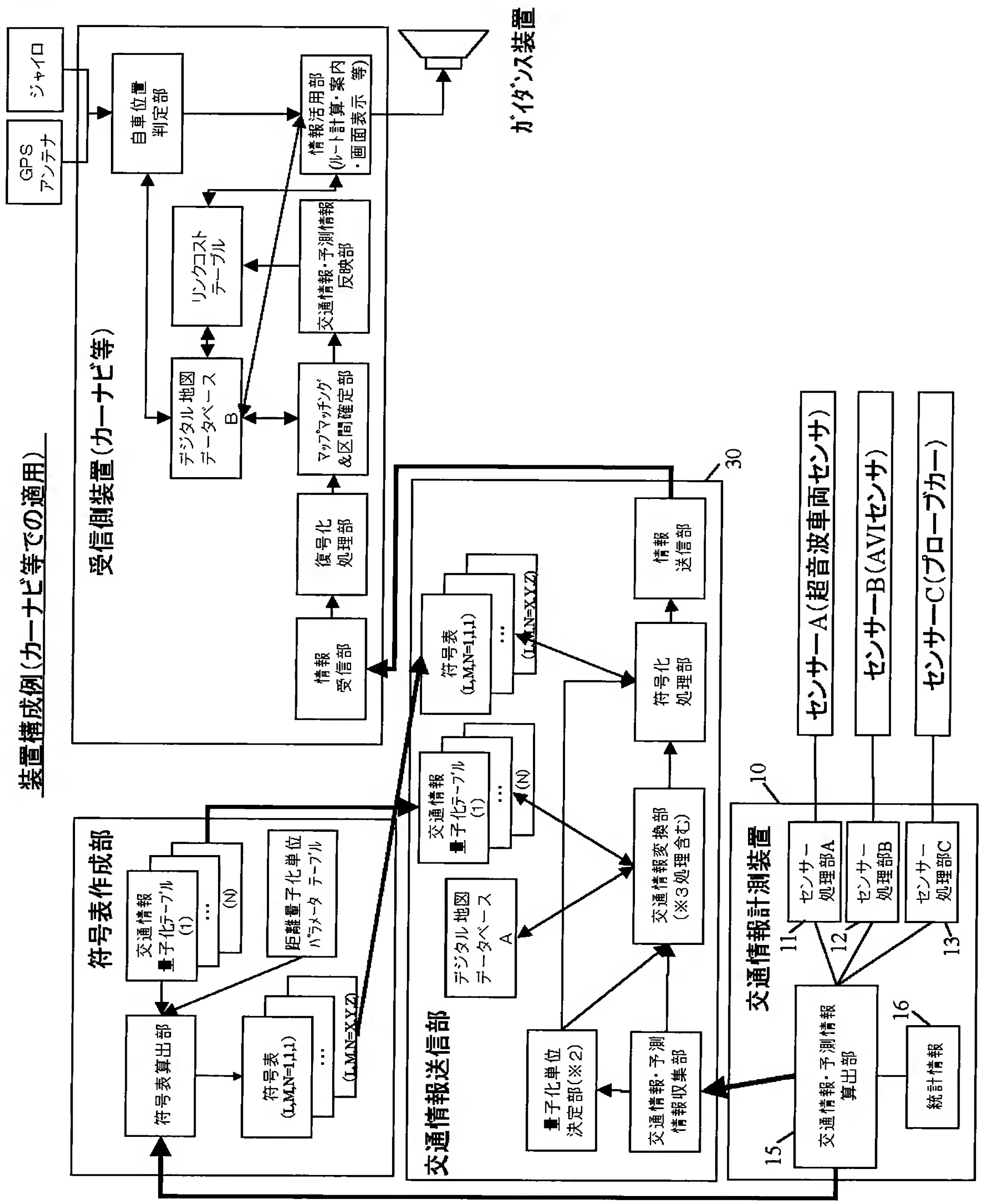
特殊コード		符号	付加ビット	
区間長変更コード		101	3(40/80/160/･･･/5120m)	
交通情報量子化テーブル変更コード		111110	4(テーブル番号)	
基準ノード対応地点識別コード		1100	6（対応する基準ノード番号）+ 8（基準ノードからのオフセット距離）	
交通情報の統計予測差分値符号表		符号	付加ビットI	付加ビットII（範囲）
ランレングス	変更量			
０	０	0	0	–
５	０	100	0	–
１０	０	1101	0	–
０	±1	1110	1(±識別)	0
０	±2	111100	1(±識別)	0
０	±4	111101	1(±識別)	1(3 or 4)
⟆				

（b）

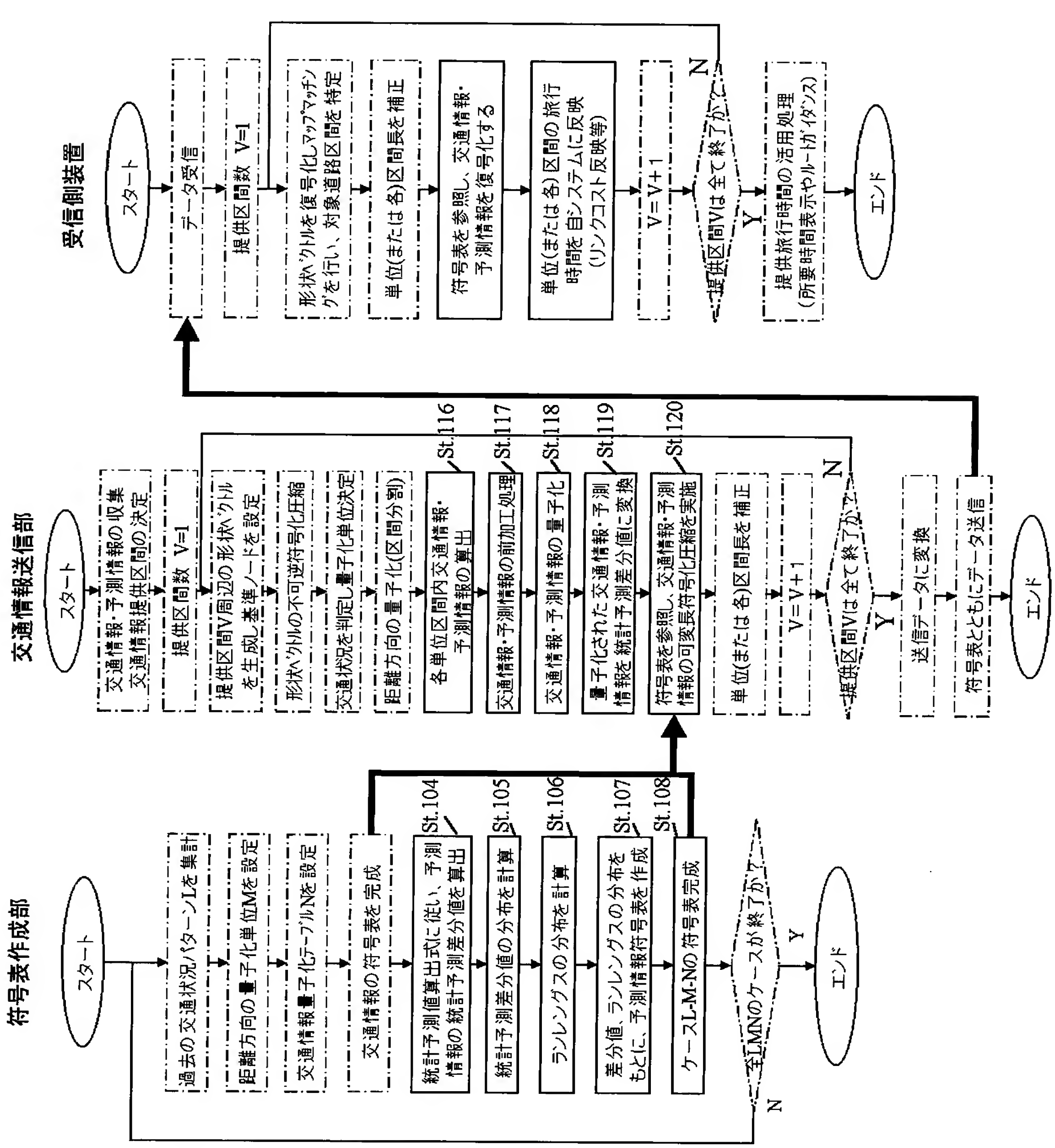
予測情報の符号表例

特殊コード		符号	付加ビット	
無し				
予測情報の統計予測差分値符号表		符号	付加ビットI	付加ビットII（範囲）
ランレングス	変更量			
０	０	0	0	–
５	０	100	0	–
１０	０	1101	0	–
０	±1	1110	1(±識別)	0
０	±2	111100	1(±識別)	0
０	±4	111101	1(±識別)	1(3 or 4)
⟆				

【図１８】


装置構成例（カーナビ等での適用）
受信側装置（カーナビ等）
GPS アンテナ
ジャイロ
自車位置判定部
情報活用部（ルート計算・案内・画面表示 等）
ガイダンス装置
リンクコストテーブル
交通情報・予測情報反映部
デジタル地図データベースB
マップマッチング&区間確定部
復号化処理部
情報受信部
符号表作成部
交通情報量子化テーブル(1)
…
(N)
距離量子化単位パラメータテーブル
符号表算出部
符号表(L,M,N=1,1,1)
…
(L,M,N=X,Y,Z)
交通情報送信部
30
情報送信部
符号化処理部
交通情報変換部（※3処理含む）
デジタル地図データベースA
量子化単位決定部（※2）
交通情報・予測情報収集部
交通情報計測装置
10
センサー処理部A
センサー処理部B
センサー処理部C
11
12
13
交通情報・予測情報算出部
15
統計情報
16
センサーA（超音波車両センサ）
センサーB（AVIセンサ）
センサーC（プローブカー）

【図１９】


符号表作成部
スタート
過去の交通状況パターンLを集計
距離方向の量子化単位Mを設定
交通情報量子化テーブルNを設定
交通情報の符号表を完成
統計予測値算出式に従い、予測情報の統計予測差分値を算出
St.104
統計予測差分値の分布を計算
St.105
ランレングスの分布を計算
St.106
差分値、ランレングスの分布をもとに、予測情報符号表を作成
St.107
ケースL-M-Nの符号表完成
St.108
全LMNのケースが終了か？
Y
N
エンド
交通情報送信部
スタート
交通情報・予測情報の収集
交通情報提供区間の決定
提供区間数 V=1
提供区間V周辺の形状ベクトルを生成、基準ノードを設定
形状ベクトルの不可逆符号化圧縮
交通状況を判定し量子化単位決定
距離方向の量子化(区間分割)
各単位区間内交通情報・予測情報の算出
St.116
交通情報・予測情報の前加工処理
St.117
交通情報・予測情報の量子化
St.118
量子化された交通情報・予測情報を統計予測差分値に変換
St.119
符号表を参照し、交通情報・予測情報の可変長符号化圧縮を実施
St.120
単位(または各)区間長を補正
V=V+1
提供区間Vは全て終了か？
N
Y
送信データに変換
符号表とともにデータ送信
エンド
受信側装置
スタート
データ受信
提供区間数 V=1
形状ベクトルを復号化しマップマッチングを行い、対象道路区間を特定
単位(または各)区間長を補正
符号表を参照し、交通情報・予測情報を復号化する
単位(または各)区間の旅行時間を自システムに反映(リンクコスト反映等)
V=V+1
提供区間Vは全て終了か？
N
Y
提供旅行時間の活用処理(所要時間表示やルートガイダンス)
エンド

【図２０】

本方式でのデータ構成例（情報交換フォーマット）

（a）

形状ベクトルデータ列情報
（前述に同じ）

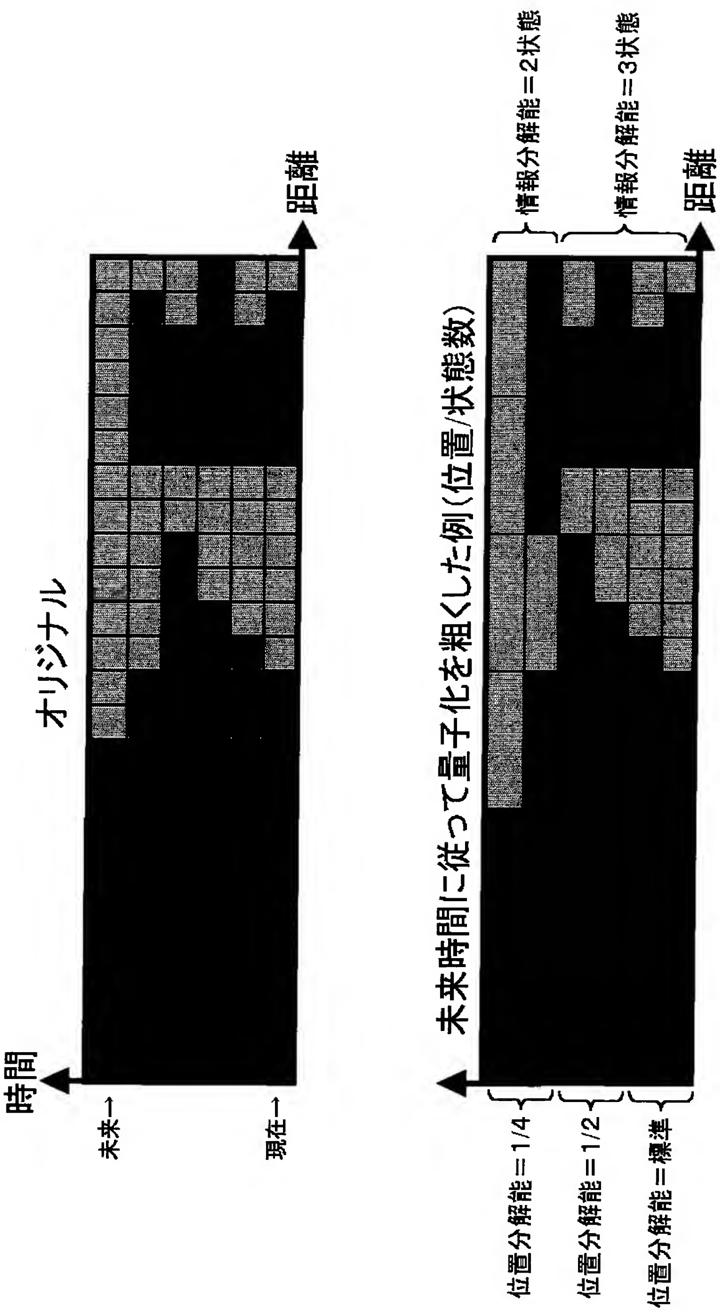
ヘッダ情報	
形状ベクトル数　N	
形状ベクトルデータ識別番号＝1	
符号表識別コード	
形状取得元 地図データ の精度情報	
一方通行方向(順/逆/無)	
始端ノード番号ps	
ノードpsX方向絶対座標(経度)	
ノードpsY方向絶対座標(緯度)	
ノードps絶対方位	
ps位置誤差(m)	ps方位誤差(°)
符号化形状データの最大位置誤差(m)	符号化形状データの最大方位誤差(°)
符号化された形状データ なお、次の情報も含む ・基準ノード設定コード ・区間長変更コード ・EODコード	
終端ノード番号pe	
ノードpeX方向相対座標(経度)	
ノードpeY方向相対座標(緯度)	
ノードpe絶対方位	
pe位置誤差(m)	pe方位誤差(°)
∫	
形状ベクトルデータ識別番号＝M	
∫	

（b）

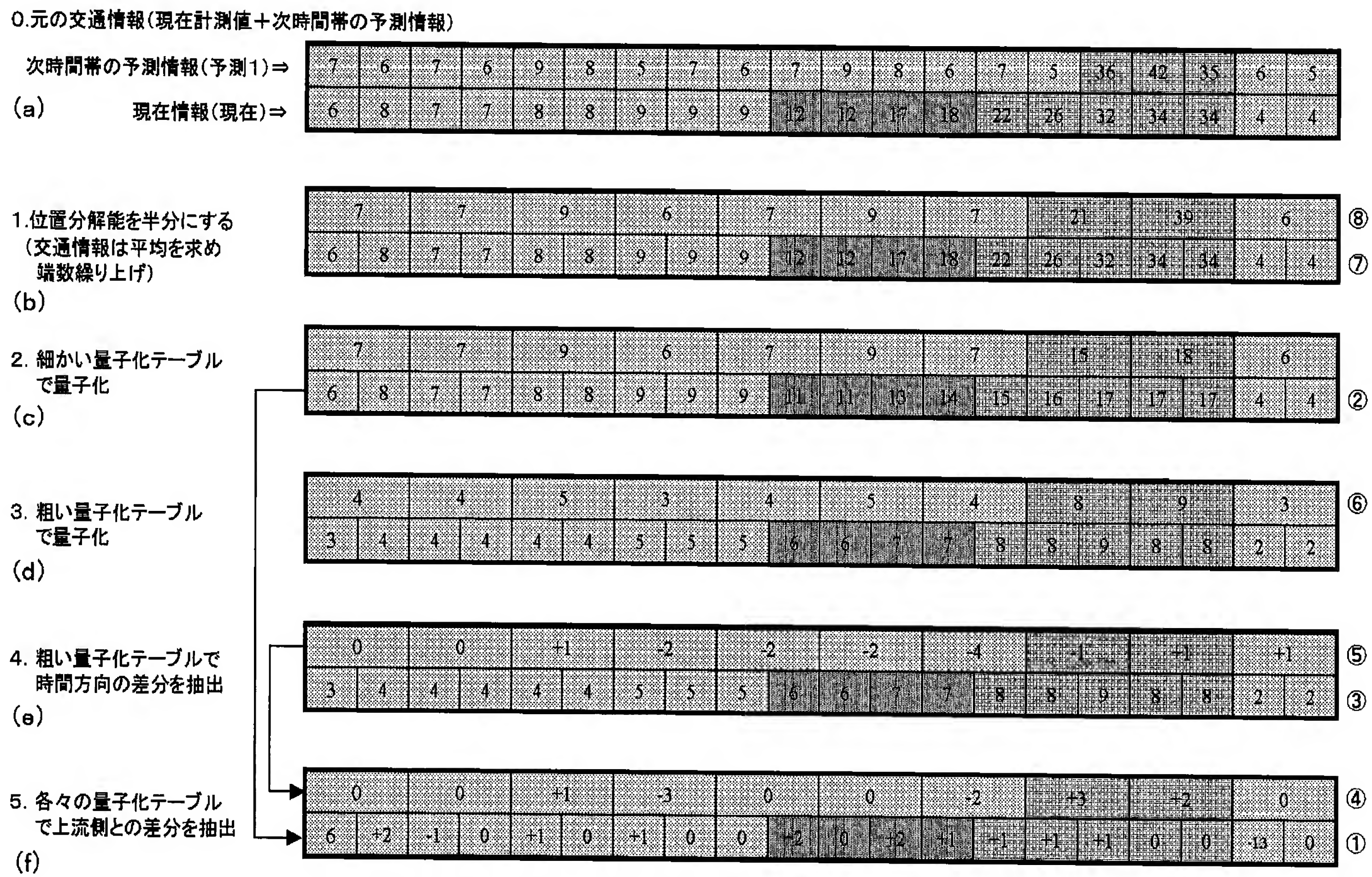
交通情報

ヘッダ情報		
交通情報提供区間数　V		
交通情報提供区間シリアル番号　1		
参照形状ベクトル列番号=N		
方向識別フラグ（順方向/逆方向）		
始端側基準ノードPa	終端側基準ノードPb	
距離方向の量子化区間長識別コード		
交通情報量子化テーブル識別コード		
現在情報：符号表識別コード		
予測情報：符号表識別コード		★
量子化された単位区間の数		
予測情報の時間帯数Q		★
現在情報の有効時間(HH:MM)		★
始端の交通情報（初期値）		
隣接地点との統計予測値差分値で符号化された現在交通情報		
予測情報1の有効時間帯(HH:MM～HH:MM)		★
前時間帯の差分および隣接地点との統計予測差分値で符号化された予測交通情報		★
∫		★
予測情報Qの有効時間帯(HH:MM～HH:MM)		
前時間帯の差分および隣接地点との統計予測差分値で符号化された予測交通情報		★
交通情報提供区間シリアル番号＝2		
∫		

【図２１】


オリジナル
距離
時間
未来→
現在→
未来時間に従って量子化を粗くした例(位置/状態数)
情報分解能＝2状態
情報分解能＝3状態
距離
位置分解能＝1/4
位置分解能＝1/2
位置分解能＝標準

【図２２】



0.元の交通情報（現在計測値＋次時間帯の予測情報）
次時間帯の予測情報（予測1）⇒
7 6 7 6 9 8 5 7 6 7 9 8 6 7 5 36 42 35 6 5
(a)
現在情報（現在）⇒
6 8 7 7 8 8 9 9 9 12 12 17 18 22 26 32 34 34 4 4
1.位置分解能を半分にする
（交通情報は平均を求め
端数繰り上げ）
(b)
7 7 9 6 7 9 7 21 39 6
⑧
6 8 7 7 8 8 9 9 9 12 12 17 18 22 26 32 34 34 4 4
⑦
2. 細かい量子化テーブル
で量子化
(c)
7 7 9 6 7 9 7 15 18 6
6 8 7 7 8 8 9 9 9 11 11 13 14 15 16 17 17 17 4 4
②
3. 粗い量子化テーブル
で量子化
(d)
4 4 5 3 4 5 4 8 9 3
⑥
3 4 4 4 4 4 5 5 5 6 6 7 7 8 8 9 8 8 2 2
4. 粗い量子化テーブルで
時間方向の差分を抽出
(e)
0 0 +1 -2 -2 -2 -4 -1 +1 +1
⑤
3 4 4 4 4 4 5 5 5 6 6 7 7 8 8 9 8 8 2 2
③
5. 各々の量子化テーブル
で上流側との差分を抽出
(f)
0 0 +1 -3 0 0 -2 +3 +2 0
④
6 +2 -1 0 +1 0 +1 0 0 +2 0 +2 +1 +1 +1 +1 0 0 -13 0
①

【図２３】

交通情報量子化テーブル（速度量子化テーブル）

<table>
<tr><th>速度（km/h）</th><th>量子化量（現在）</th><th>量子化量（予測1）</th><th>量子化量（予測2）</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td rowspan="2">1</td><td rowspan="4">1</td></tr>
<tr><td>2</td><td>2</td></tr>
<tr><td>3</td><td>3</td><td rowspan="2">2</td></tr>
<tr><td>4</td><td>4</td></tr>
<tr><td>5</td><td>5</td><td rowspan="2">3</td><td rowspan="4">2</td></tr>
<tr><td>6</td><td>6</td></tr>
<tr><td>7</td><td>7</td><td rowspan="2">4</td></tr>
<tr><td>8</td><td>8</td></tr>
<tr><td>9</td><td>9</td><td rowspan="2">5</td><td rowspan="4">3</td></tr>
<tr><td>10～11</td><td>10</td></tr>
<tr><td>12～13</td><td>11</td><td rowspan="2">6</td></tr>
<tr><td>14～15</td><td>12</td></tr>
<tr><td>16～17</td><td>13</td><td rowspan="2">7</td><td rowspan="4">4</td></tr>
<tr><td>18～19</td><td>14</td></tr>
<tr><td>20～24</td><td>15</td><td rowspan="2">8</td></tr>
<tr><td>25～29</td><td>16</td></tr>
<tr><td>30～34</td><td>17</td><td rowspan="2">9</td><td rowspan="4">5</td></tr>
<tr><td>35～39</td><td>18</td></tr>
<tr><td>40～44</td><td>19</td><td rowspan="2">10</td></tr>
<tr><td>45～49</td><td>20</td></tr>
<tr><td>50～59</td><td>21</td><td rowspan="2">11</td><td rowspan="4">6</td></tr>
<tr><td>60～69</td><td>22</td></tr>
<tr><td>70～79</td><td>23</td><td rowspan="2">12</td></tr>
<tr><td>80～99</td><td>24</td></tr>
<tr><td colspan="4">≀</td></tr>
<tr><td>200以上</td><td>30</td><td>15</td><td>8（180km/h以上）</td></tr>
</table>

【図２４】

交通情報

ヘッダ情報		
交通情報提供区間数　V		
交通情報提供区間シリアル番号　1		
参照形状ベクトル列番号=N		
方向識別フラグ（順方向/逆方向）		
始端側基準ノードPa	終端側基準ノードPb	
距離方向の量子化区間長識別コード		
交通情報量子化テーブル識別コード		
現在情報：符号表識別コード		
予測情報：符号表識別コード		
量子化された単位区間の数		
予測情報の時間帯数Q		
現在情報の有効時間(HH:MM)		
始端の交通情報（初期値）		
統計予測値との差分値で 符号化された現在交通情報		
予測情報1の有効時間帯(HH:MM～HH:MM)		
位置分解能識別コード	量子化テーブル番号	★
統計予測値との差分値で 符号化された予測交通情報		
～		
予測情報Qの有効時間帯(HH:MM～HH:MM)		
位置分解能識別コード	量子化テーブル番号	★
統計予測値との差分値で 符号化された予測交通情報		
交通情報提供区間シリアル番号＝2		
～		

【図２５】

③	●
②	①

●の統計予測値＝a①＋b②＋c③（ただし a＋b＋c＝1）
　または　＝（①＋③）÷2

【図２６】

① 元の交通情報データ

速度情報	渋滞情報
6	10
8	10
7	10
7	10
8	10
8	10
9	10
9	10
9	10
12	20
12	20
17	20
18	20
22	20
26	20
32	20
34	20
34	20
4	10
4	10
6	10
7	10
41	40
46	40
46	40
38	40
43	40
44	40
40	40
45	40
48	40
43	40

⇒

② 送信装置（エンコーダ）側でのFFT変換処理

元のデータを虚数表現	FFT変換後のFFT係数
6+10i	733+710i
8+10i	-148.621280158602+272.745598987757i
7+10i	-181.863253323699+137.343315457237i
7+10i	-55.471398331421 1-53.4484277168883i
8+10i	26.9411254969544+120.225396744416i
8+10i	-145.189119855325+0.961716183533575i
9+10i	0.190731976517859-15.5222872819433i
9+10i	-40.9017001665513+42.9151819467876i
9+10i	-43-1.99999999999999i
12+20i	-54.8878935485916-20.3048255517509i
12+20i	-14.5874741515445-8.38147222871013i
17+20i	-39.7513380295353+5.30246359471074i
18+20i	-9.2253967444162-52.3431457505075i
22+20i	-10.7100733299521+24.6722184685535i
26+20i	-54.8564177147756-9.86802548368202i
32+20i	6.72547424221385-31.6849567666283i
34+20i	-19-10i
34+20i	-23.9885463768037-1.92475231338796i
4+10i	-27.1316960424174-35.6032000870592i
4+10i	19.5410942063395-19.8773345808547i
6+10i	-40.9411254969543-4.22539674441614i
7+10i	3.86349685861286-50.425876865859i
41+40i	7.38286115228 94+26.1152163945066i
46+40i	-45.9968033955987-35.2659030736415i
46+40i	-3.00000000000002-58i
38+40i	6.81142858298211-29.3789361327705i
43+40i	3.58242351766113+2.64135685853256i
44+40i	-40.7691513342156-119.976701296968i
40+40i	115.225396744416-63.6568542494925i
45+40i	-91.2780121723207+19.6548572239245i
48+40i	147.282824585968-256.724903628881i
43+40i	212.623822808768-163.964322106518i

⇒

③ ④ 送信データ

量子化テーブル	FFT実部量子化係数	FFT虚部量子化係数
4	183	178
4	-37	68
4	-45	34
4	-14	-13
4	7	30
4	-36	0
8	0	-2
8	-5	5
8	-5	0
8	-7	-3
8	-2	-1
8	-5	1
16	-1	-3
16	-1	2
16	-3	-1
16	0	-2
16	-1	-1
16	-1	0
32	-1	-1
32	1	-1
32	-1	0
32	0	-2
32	0	1
32	-1	-1
32	0	-2
32	0	-1
64	0	0
64	-1	-2
64	2	-1
64	-1	0
64	2	-4
64	3	-3

⇒

⑤ 受信装置（デコーダ）側での逆FFT変換処理

受信データを虚数表現	逆FFT変換後の逆FFT係数
732+712i	5.75+7.625i
-148+272i	5.80532548203367+8.52067305321167i
-180+136i	6.23420537707197+10.5005693367913i
-56-52i	4.98101229726206+9.37963294127272i
28+120i	6.57322330470337+9.69822330470336i
-144	6.42632544638239+10.2678775231286i
-16i	5.42212789881637+11.570897252652i
-40+40i	9.60303478897502+13.5436449478559i
-40	10.25+11.375i
-56-24i	12.3363273925689+20.4980722500786i
-16-8i	13.183549755522+21.8443947771475i
-40+8i	18.4482141856231+17.8569282303024i
-16-48i	17.4362915010152+18.5183982822018i
-16+32i	18.4819265012166+20.2722369810842i
-48-16i	25.9598985734648+21.2477458001796i
-32i	30.9783456673565+20.9626867300298i
-16-16i	34+22.375i
-16	35.4245017907487+21.5758249081537i
-32-32i	3.71160092966191+9.77366409468866i
32-32i	5.59046498433584+12.5736086644321i
-32	6.92677669529664+10.0517766952966i
-64i	8.67433416713155+12.9347385137643i
32i	43.7767267351224+38.7596853649321i
-32-32i	47.648662535459+39.2058071703952i
-64i	48+38.625i
-32i	37.9442529747343+37.1731967415224i
0	42.3706439377441+38.3813717913725i
-64-128i	42.4282703323508+39.5728208061088i
128-64i	40.0637084989847+39.7316017177982i
-64	45.9070062451838+40.7573800290564i
128-256i	48.3412467925964+37.9216715822364i
192-192i	43.3219952086377+38.9048705096031i

⇒

⑥ 復元交通情報データ

速度情報	渋滞情報
6	8
6	9
6	11
5	9
7	10
6	10
5	12
10	14
10	11
12	20
13	22
18	18
17	19
18	20
26	21
31	21
34	22
35	22
4	10
6	13
7	10
9	13
44	39
48	39
48	39
38	37
42	38
42	40
40	40
46	41
48	38
43	39

⑦ 元−復元データ間差異

速度情報	渋滞情報
0	-2
-2	-1
-1	1
-2	-1
-1	0
-2	0
-4	2
1	4
1	1
0	0
1	2
1	-2
-1	-1
-4	0
0	1
-1	1
0	2
1	2
0	0
2	3
1	0
2	3
3	-1
2	-1
2	-1
0	-3
-1	-2
-2	0
0	0
1	1
0	-2
0	-1

【図２７】

①

元の交通情報データ	
速度情報	渋滞情報
6	10
8	10
7	10
7	10
8	10
8	10
9	10
9	10
9	10
12	20
12	20
17	20
18	20
22	20
26	20
32	20
34	20
34	20
4	10
4	10
6	10
7	10
41	40
46	40
46	40
38	40
43	40
44	40
40	40
45	40
48	40
43	40

⇒

②

送信装置(エンコーダ)側でのFFT変換処理	
元のデータを虚数表現	FFT変換後のFFT係数
6+10i	733+710i
8+10i	-148.621280158602+272.745598987757i
7+10i	-181.863253323699+137.343315457237i
7+10i	-55.4713983314211-53.4484277168883i
8+10i	26.9411254969544+120.225396744416i
8+10i	-145.189119855325+0.961716183533575i
9+10i	0.190731976517859-15.5222872819433i
9+10i	-40.9017001665513+42.9151819467876i
9+10i	-43-1.99999999999999i
12+20i	-54.8878935485916-20.3048255517509i
12+20i	-14.5874741515445-8.38147222871013i
17+20i	-39.7513380295353+5.30246359471074i
18+20i	-9.2253967444162-52.3431457505075i
22+20i	-10.7100733299521+24.6722184685535i
26+20i	-54.8564177147756-9.86802548368202i
32+20i	6.72547424221385-31.6849567666283i
34+20i	-19-10i
34+20i	-23.9885463768037-1.92475231338796i
4+10i	-27.1316960424174-35.6032000870592i
4+10i	19.5410942063395-19.8773345808547i
6+10i	-40.9411254969543-4.22539674441614i
7+10i	3.86349685861286-50.425876865859i
41+40i	7.3828611522894+26.1152163945066i
46+40i	-45.9968033955987-35.2659030736415i
46+40i	-3.00000000000002-58i
38+40i	6.81142858298211-29.3789361327705i
43+40i	3.58242351766113+2.64135685853256i
44+40i	-40.7691513342156-119.976701296968i
40+40i	115.225396744416-63.6568542494925i
45+40i	-91.2780121723207+19.6548572239245i
48+40i	147.282824585968-256.724903628881i
43+40i	212.623822808768-163.964322106518i

⇒

③ ④

量子化テーブル	送信データ	
	FFT実部量子化係数	FFT虚部量子化係数
1	733	710
1	-149	273
1	-182	137
1	-55	-53
1	27	120
1	-145	1
1	0	-16
1	-41	43
2	-22	-1
2	-27	-10
2	-7	-4
2	-20	3
2	-5	-26
2	-5	12
2	-27	-5
2	3	-16
4	-5	-3
4	-6	0
4	-7	-9
4	5	-5
4	-10	-1
4	1	-13
4	2	7
4	-11	-9
8	0	-7
8	1	-4
8	0	0
8	-5	-15
8	14	-8
8	-11	2
8	18	-32
8	27	-20

⇒

⑤

受信装置(デコーダ)側での逆FFT変換処理	
受信データを虚数表現	逆FFT変換後の逆FFT係数
733+710i	6.125+9.90625i
-149+273i	7.83584865307734+9.91404826084081i
-182+137i	6.76193183099866+10.2377953874i
-55-53i	7.32835127918787+10.5062773120751i
27+120i	8.20932765030735+9.98169417382415i
-145+i	8.18580581859386+9.78820767533622i
-16i	8.75920065770712+9.95194659570465i
-41+43i	9.36655308744802+10.3939434767794i
-44-2i	9.43750000000001+10.03125i
-54-20i	12.3785026290064+19.6115974881206i
-14-8i	12.1384947423615+19.6588010321639i
-40+6i	17.0969218083576+19.766891185662i
-10-52i	17.876012370136+19.7652574989709i
-10+24i	22.2422829603499+19.8026220654219i
-54-10i	25.8666734821883+19.2785860749779i
6-32i	31.3618699248875+19.744220432985i
-20-12i	33.375+20.03125i
-24	33.859203656747+20.2144116879971i
-28-36i	3.90928708309759+10.0699089132008i
20-20i	4.01415042944684+10.5218714515286i
-40-4i	6.35317234969266+9.89330582617583i
4-52i	7.0156619415876+9.93582863295567i
8+28i	40.9882898882974+39.668388457462i
-44-36i	45.7309644994616+40.2483517725244i
-56i	45.8125+40.03125i
8-32i	37.9860274865302+40.0480783789956i
0	42.8152863435422+40.1584946672352i
-40-120i	43.7093634973042+40.194105993465i
112-64i	40.0614876298639+40.3597425010291i
-88+16i	45.2466668541078+40.1852058103321i
144-256i	48.0108359718072+39.9760788718555i
216-160i	43.1418254739263+40.1243383749805i

⇒

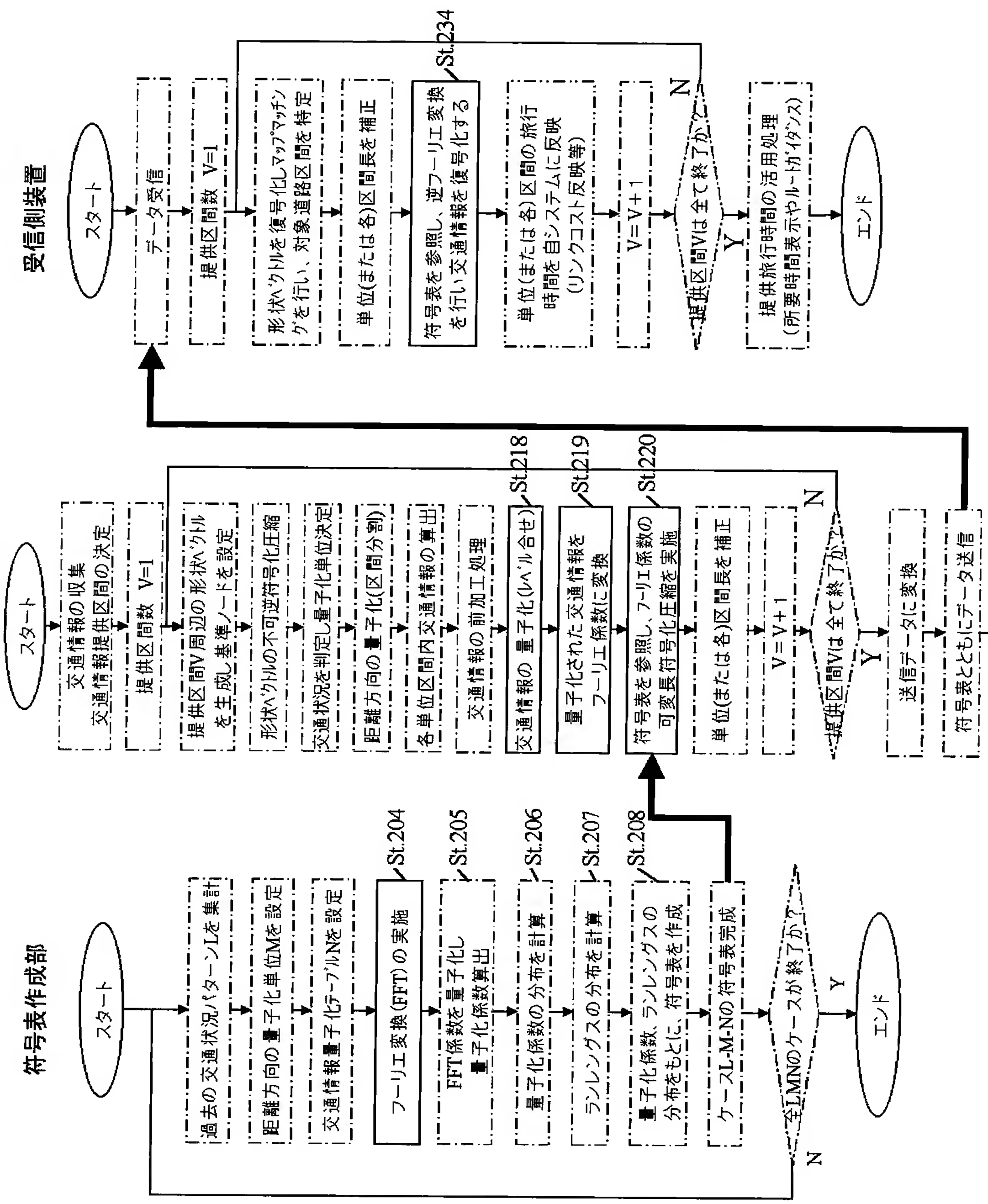
⑥

復元交通情報データ	
速度情報	渋滞情報
6	10
8	10
7	10
7	11
8	10
8	10
9	10
9	10
9	10
12	20
12	20
17	20
18	20
22	20
26	19
31	20
33	20
34	20
4	10
4	11
6	10
7	10
41	40
46	40
46	40
38	40
43	40
44	40
40	40
45	40
48	40
43	40

⑦

元-復元データ間差異	
速度情報	渋滞情報
0	0
0	0
0	0
0	1
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	-1
-1	0
-1	0
0	0
0	0
0	1
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0

【図２８】


符号表作成部
スタート
過去の交通状況パターンLを集計
距離方向の量子化単位Mを設定
交通情報量子化テーブルNを設定
フーリエ変換(FFT)の実施
St.204
FFT係数を量子化し量子化係数算出
St.205
量子化係数の分布を計算
St.206
ランレングスの分布を計算
St.207
量子化係数、ランレングスの分布をもとに、符号表を作成
St.208
ケースL-M-Nの符号表完成
全LMNのケースが終了か？
Y
N
エンド
交通情報送信部
スタート
交通情報の収集
交通情報提供区間の決定
提供区間数 V=1
提供区間V周辺の形状ベクトルを生成し基準ノードを設定
形状ベクトルの不可逆符号化圧縮
交通状況を判定し量子化単位決定
距離方向の量子化(区間分割)
各単位区間内交通情報の算出
交通情報の前加工処理
交通情報の量子化(レベル合せ)
St.218
量子化された交通情報をフーリエ係数に変換
St.219
符号表を参照し、フーリエ係数の可変長符号化圧縮を実施
St.220
単位(または各)区間長を補正
V=V+1
提供区間Vは全て終了か？
N
Y
送信データに変換
符号表とともにデータ送信
エンド
受信側装置
スタート
データ受信
提供区間数 V=1
形状ベクトルを復号化しマップマッチングを行い、対象道路区間を特定
単位(または各)区間長を補正
符号表を参照し、逆フーリエ変換を行い交通情報を復号化する
St.234
単位(または各)区間の旅行時間を自システムに反映(リンクコスト反映等)
V=V+1
提供区間Vは全て終了か？
N
Y
提供旅行時間の活用処理(所要時間表示やルートガイダンス)
エンド

【図２９】

FFT表現した交通情報の例

<table>
<tr><td colspan="2">ヘッダ情報</td></tr>
<tr><td colspan="2">交通情報提供区間数　V</td></tr>
<tr><td colspan="2">交通情報提供区間シリアル番号　1</td></tr>
<tr><td colspan="2">参照形状ベクトル列番号=N</td></tr>
<tr><td colspan="2">方向識別フラグ（順方向/逆方向）</td></tr>
<tr><td>始端側基準ノードPa</td><td>終端側基準ノードPb</td></tr>
<tr><td colspan="2">交通情報量子化テーブル識別コード</td></tr>
<tr><td colspan="2">符号表識別コード</td></tr>
<tr><td colspan="2">基準ノード間の区間分割数　2^N</td></tr>
<tr><td colspan="2">フーリエ係数を、実数部・虚数部の順に、
低周波成分の係数→高周波成分の係数
の順に可変長符号化したデータ列</td></tr>
<tr><td colspan="2">～</td></tr>
<tr><td colspan="2">交通情報提供区間シリアル番号＝W</td></tr>
<tr><td colspan="2">～</td></tr>
</table>

【図３０】

FFT係数の符号表例

特殊コード		符号	付加ビット	
EODコード		1100	無し	
符号表		符号	付加ビットⅠ	付加ビットⅡ（範囲）
ランレングス	FFT係数			
0	0	0	0	—
5	0	100	0	—
10	0	1101	0	—
0	±1	1110	1(±識別)	0
0	±2	111100	1(±識別)	0
0	±3〜6	111101	1(±識別)	2（3 /4/5/6の識別）
∫				

【図３１】

FFT表現した交通情報の例2
（低周波成分/高周波成分　分割型）

（a）

ヘッダ情報	
本情報の番号	交通情報分割数
交通情報提供区間数　V	
交通情報提供区間シリアル番号　1	
参照形状ベクトル列番号=N	
方向識別フラグ（順方向/逆方向）	
始端側基準ノードPa	終端側基準ノードPb
交通情報量子化テーブル識別コード	
符号表識別コード	
基準ノード間の区間分割数　2^N	
フーリエ係数を、実数部・虚数部の順に、基底関数の係数→高周波成分の順に可変長符号化したデータ列	
∫	
交通情報提供区間シリアル番号＝W	
∫	

基本的な情報＆低周波成分のFFT係数情報

（b）

ヘッダ情報	
本情報の番号※	交通情報分割数※
交通情報提供区間シリアル番号　1	
フーリエ係数を、実数部・虚数部の順に、基底関数の係数→高周波成分の順に可変長符号化したデータ列	
∫	
交通情報提供区間シリアル番号＝W	
∫	

高周波成分のFFT係数情報
（何分割かされたものの一部）

【図３２】

(a)

通常の送信順序
（区間番号順に、低周波成分→高周波成分を順次送信）

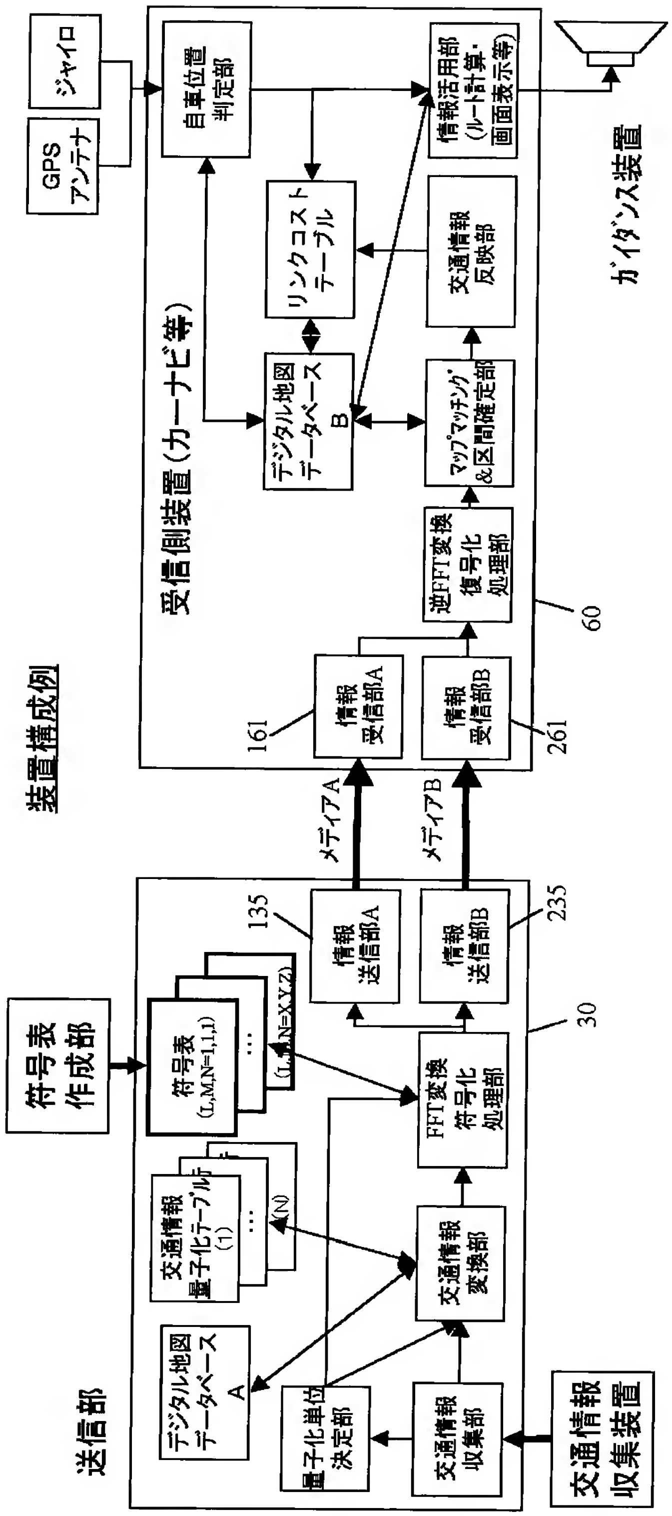
区間番号＝1 の情報(FFT係数)		区間番号＝2 の情報(FFT係数)			区間番号＝V の情報(FFT係数)	
実数部	虚数部	実数部	虚数部		実数部	虚数部
45	64	-13	87		53	16
34	-22	8	-32		-89	45
25	-7	5	27		14	-22
0	6	-4	-4		0	19
-2	0	0	3		2	-21
-14	0	-8	0		-4	-6
3	-4	2	-9		0	0
0	0	3	0		-5	-3
0	1	0	6		9	0
0	12	0	8	～	8	0
-2	-5	4	12		4	6
0	0	0	0		0	-12
-1	0	2	0		3	0
3	1	-4	3		5	-3
-2	-7	0	-2		0	0
0	0	0	-1		1	4
0	1	0	7		-3	0
0	0	3	0		-2	1
-6	0	0	0		0	0
3	6	6	0		0	0
4	0	0	4		0	0
	～					
1	0	-2	-1		0	-2

(b)

本方式の送信順序
（全区間の低周波成分を送信し、順次高周波成分を送信）

区間番号＝1 の情報(FFT係数)		区間番号＝2 の情報(FFT係数)			区間番号＝V の情報(FFT係数)	
実数部	虚数部	実数部	虚数部		実数部	虚数部
45	64	-13	87		53	16
34	-22	8	-32		-89	45
25	-7	5	27		14	-22
0	6	-4	-4		0	19
-2	0	0	3		2	-21
-14	0	-8	0		-4	-6
3	-4	2	-9		0	0
0	0	3	0		-5	-3
0	1	0	6		9	0
0	12	0	8	～	8	0
-2	-5	4	12		4	6
0	0	0	0		0	-12
-1	0	2	0		3	0
3	1	-4	3		5	-3
-2	-7	0	-2		0	0
0	0	0	-1		1	4
0	1	0	7		-3	0
0	0	3	0		-2	1
-6	0	0	0		0	0
3	6	6	0		0	0
4	0	0	4		0	0
	～				～	
1	0	-2	-1		0	-2

【図３３】


装置構成例
送信部
符号表作成部
交通情報収集装置
デジタル地図データベースA
量子化単位決定部
交通情報収集部
交通情報量子化テーブル(1)
(N)
交通情報変換部
符号表(L,M,N=1,1,1)
(L,M,N=X,Y,Z)
FFT変換符号化処理部
情報送信部A
情報送信部B
135
235
30
メディアA
メディアB
受信側装置（カーナビ等）
情報受信部A
情報受信部B
161
261
60
逆FFT変換復号化処理部
マップマッチング&区間確定部
デジタル地図データベースB
リンクコストテーブル
交通情報反映部
自車位置判定部
情報活用部(ルート計算・画面表示等)
GPSアンテナ
ジャイロ
ガイダンス装置

【図３４】

もととなる交通情報

ヘッダ情報	
本情報の番号	交通情報分割数
交通情報提供区間数 V	
交通情報提供区間シリアル番号 1	
参照形状ベクトル列番号=N	
方向識別フラグ(順方向/逆方向)	
始端側基準ノードPa	終端側基準ノードPb
距離方向の量子化区間長識別コード	
交通情報量子化テーブル識別コード	
現在情報：符号表識別コード	
予測情報：符号表識別コード	
量子化された単位区間の数	
予測情報の時間帯数Q	
現在情報の有効時間(HH:MM)	
始端の交通情報(初期値)	
隣接地点との統計予測差分値で 符号化された現在交通情報	
交通情報提供区間シリアル番号＝2	
∫	

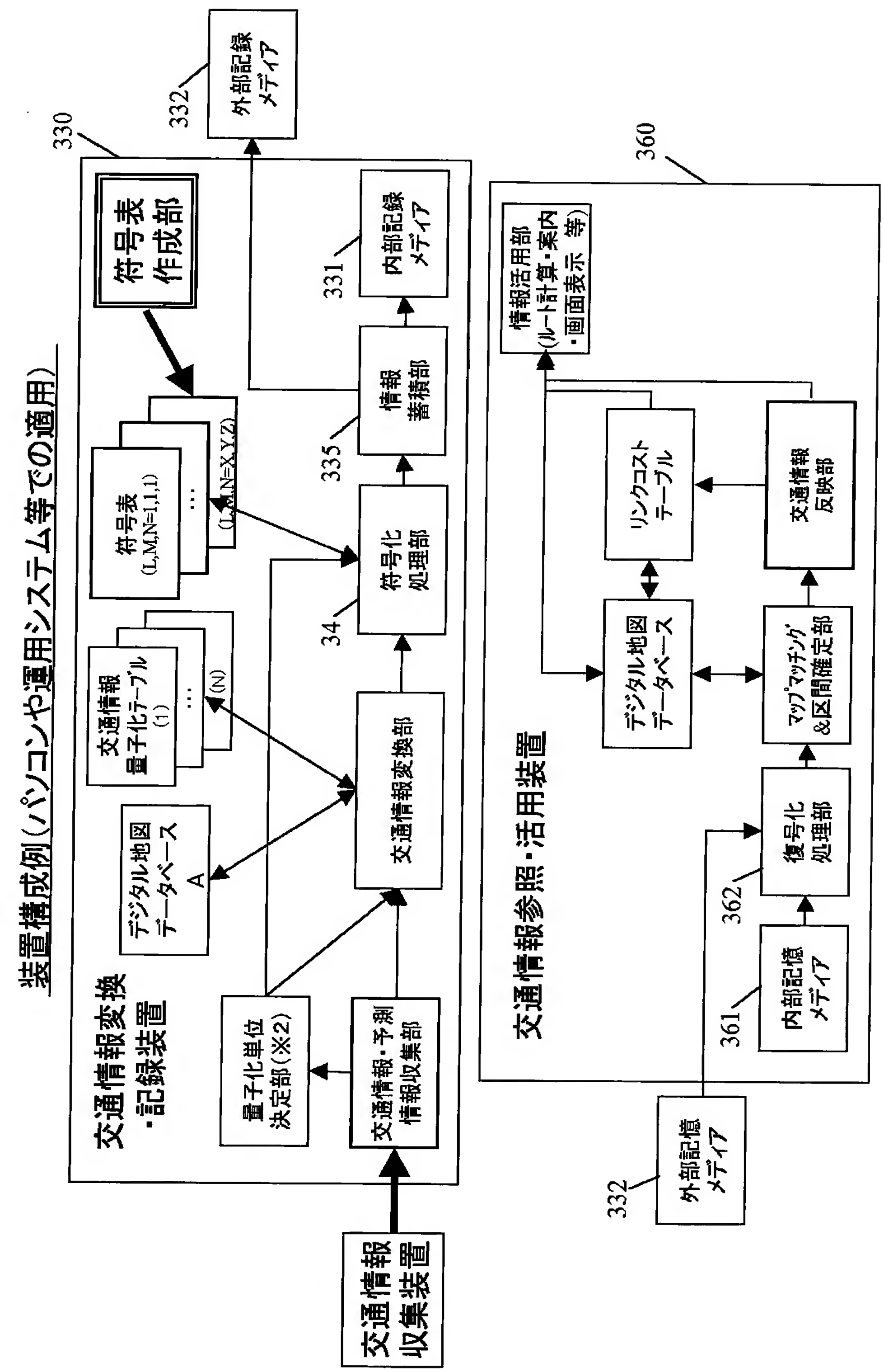
(a)

前時間帯情報との差分情報

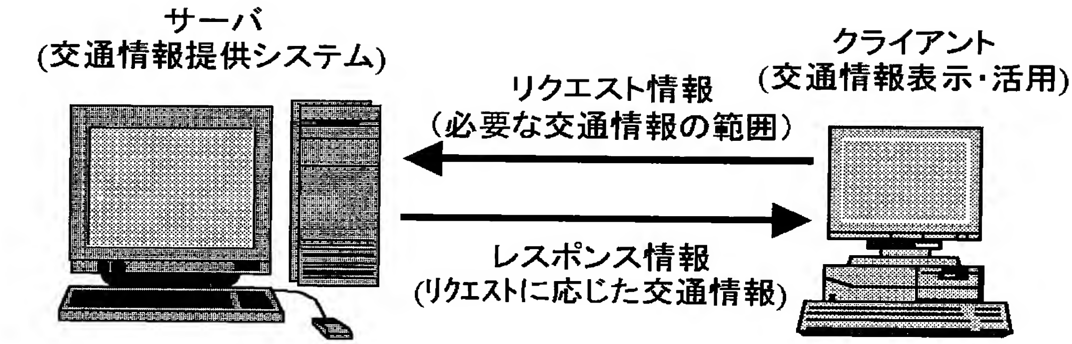
ヘッダ情報	
本情報の番号	交通情報分割数
交通情報提供区間シリアル番号 1	
符号表識別コード	
予測情報Qの有効時間帯(HH:MM～HH:MM)	
前時間帯の差分および隣接地点との統計予測 差分値で符号化された現在交通情報	
交通情報提供区間シリアル番号＝2	
∫	

(b)

【図３５】


装置構成例(パソコンや運用システム等での適用)
330
交通情報変換・記録装置
符号表作成部
符号表
(L,M,N=1,1,1)
(L,M,N=X,Y,Z)
交通情報
量子化テーブル
(1)
(N)
デジタル地図
データベース
A
交通情報変換部
34
符号化処理部
335
情報蓄積部
331
内部記録メディア
332
外部記録メディア
量子化単位
決定部(※2)
交通情報・予測
情報収集部
交通情報
収集装置
360
交通情報参照・活用装置
361
内部記憶メディア
362
復号化処理部
マップマッチング
&区間確定部
デジタル地図
データベース
リンクコスト
テーブル
交通情報
反映部
情報活用部
(ルート計算・案内
・画面表示 等)
332
外部記憶メディア

【図３６】

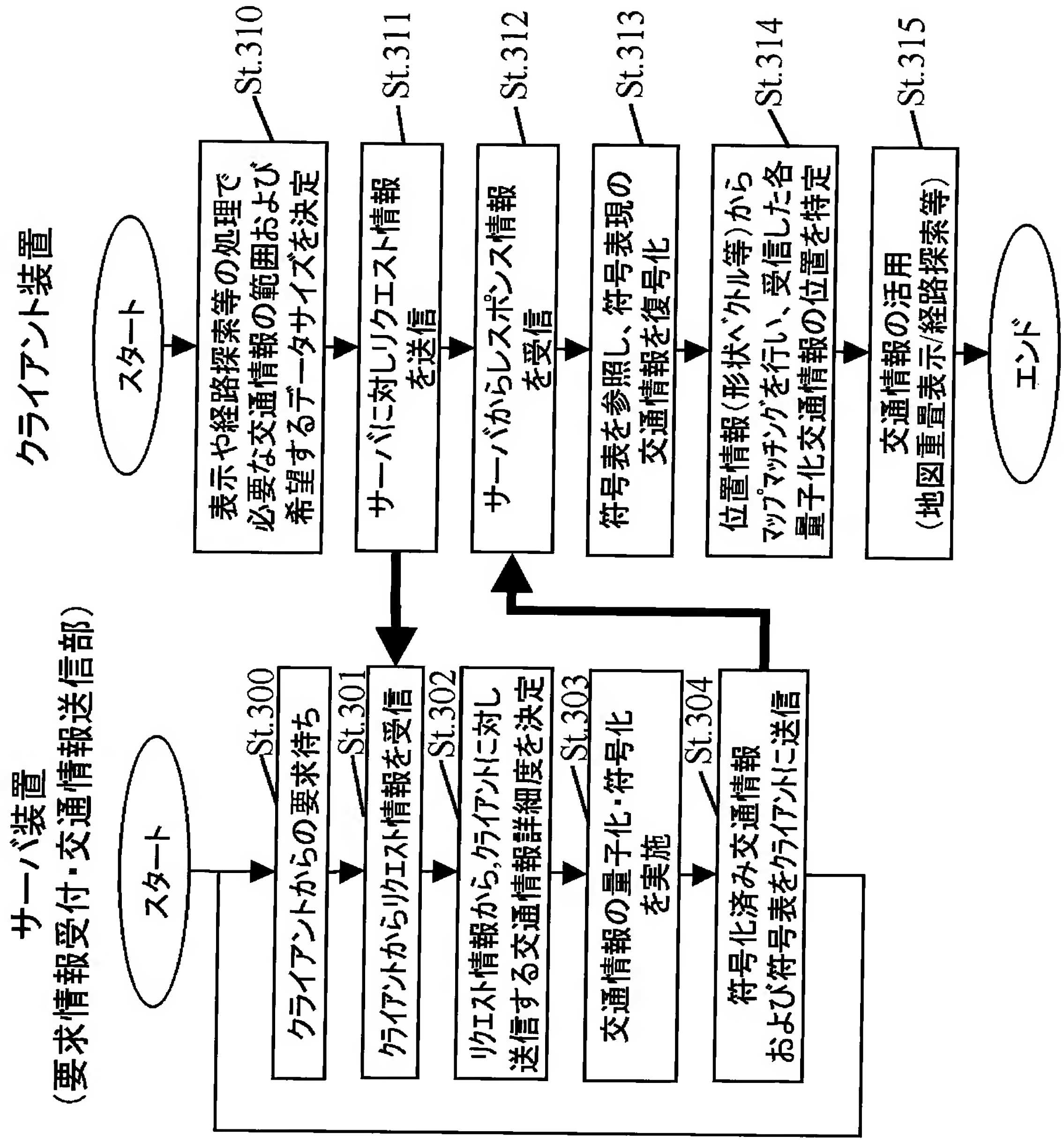


【図３７】

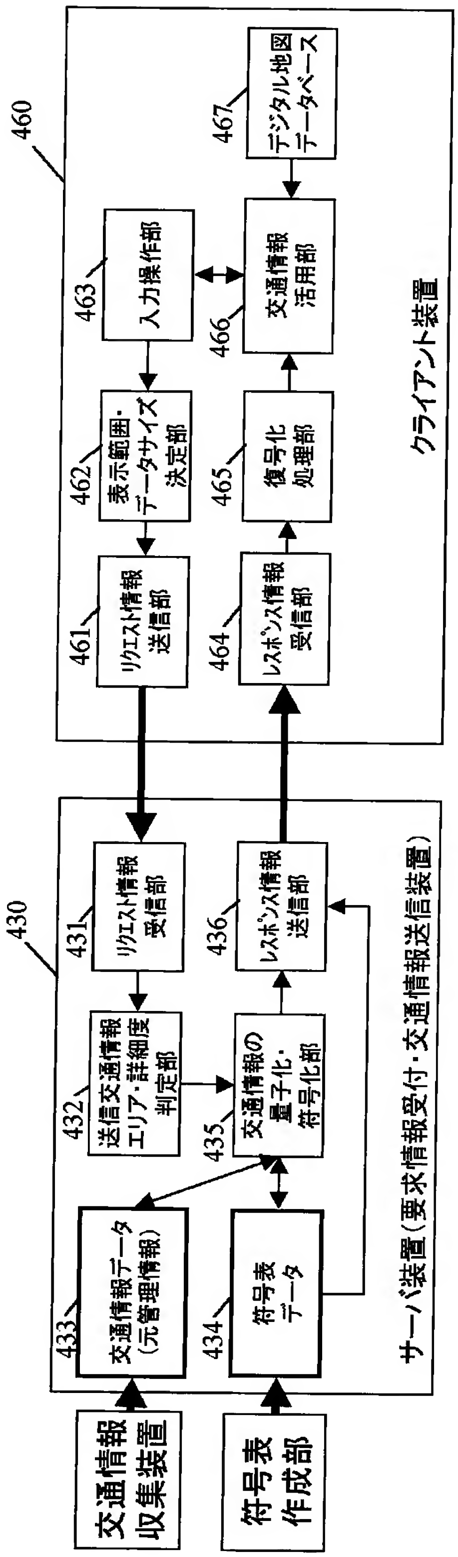
クライアント→サーバ送信情報
＜リクエスト情報＞

ヘッダ情報(ユーザID等)
希望する最大データサイズ※1
矩形の左下/右上の緯度経度※2
中心点※2
都道府県/市町村コード※2
道路指定(道路属性等)※2
経路探索要求用 始終端緯度経度※3
現在地緯度経度＋進行方位※3

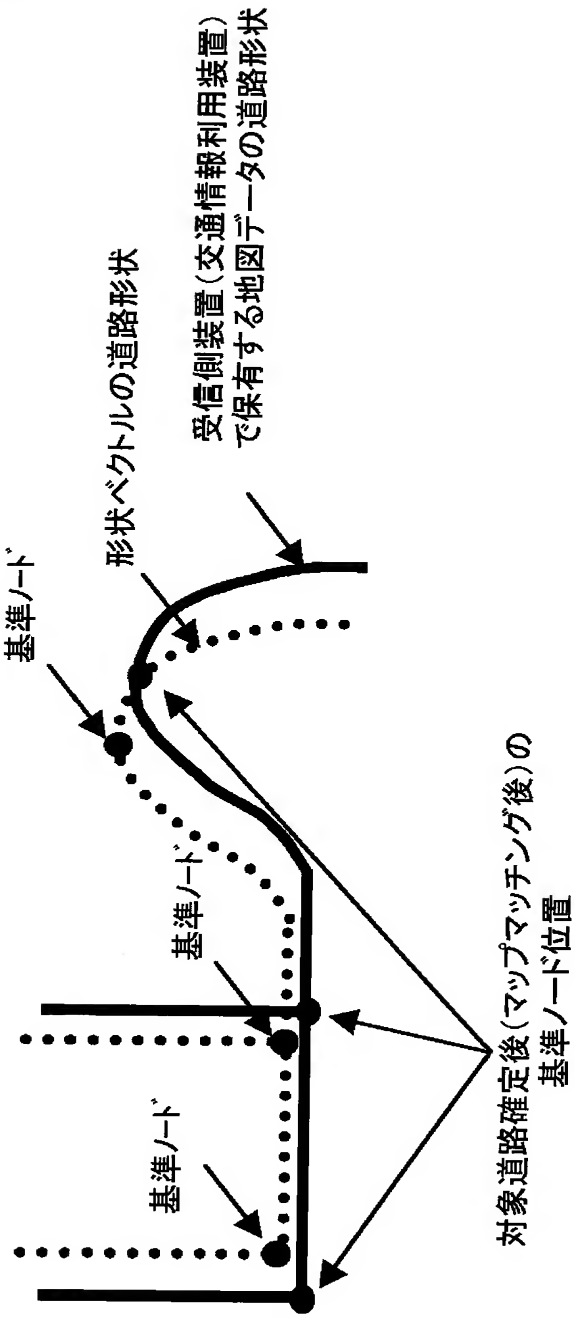
【図３８】


クライアント装置
スタート
St.310
表示や経路探索等の処理で必要な交通情報の範囲および希望するデータサイズを決定
St.311
サーバに対しリクエスト情報を送信
St.312
サーバからレスポンス情報を受信
St.313
符号表を参照し、符号表現の交通情報を復号化
St.314
位置情報（形状ベクトル等）からマップマッチングを行い、受信した各量子化交通情報の位置を特定
St.315
交通情報の活用（地図重畳表示/経路探索等）
エンド
サーバ装置
（要求情報受付・交通情報送信部）
スタート
St.300
クライアントからの要求待ち
St.301
クライアントからリクエスト情報を受信
St.302
リクエスト情報から,クライアントに対し送信する交通情報詳細度を決定
St.303
交通情報の量子化・符号化を実施
St.304
符号化済み交通情報および符号表をクライアントに送信

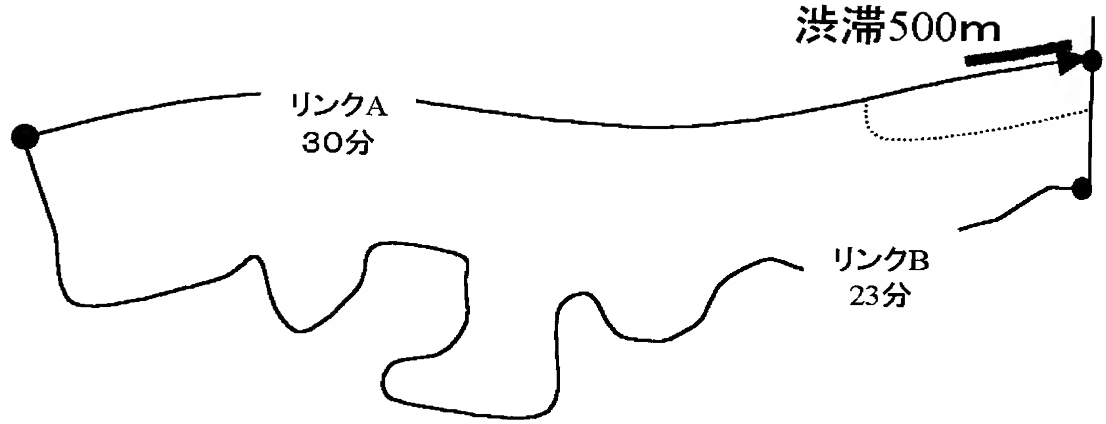
【図３９】


460
467 デジタル地図データベース
463 入力操作部
466 交通情報活用部
462 表示範囲・データサイズ決定部
465 復号化処理部
461 リクエスト情報送信部
464 レスポンス情報受信部
クライアント装置
430
431 リクエスト情報受信部
436 レスポンス情報送信部
432 送信交通情報エリア・詳細度判定部
435 交通情報の量子化・符号化部
433 交通情報データ（元管理情報）
434 符号表データ
サーバ装置（要求情報受付・交通情報送信装置）
交通情報収集装置
符号表作成部

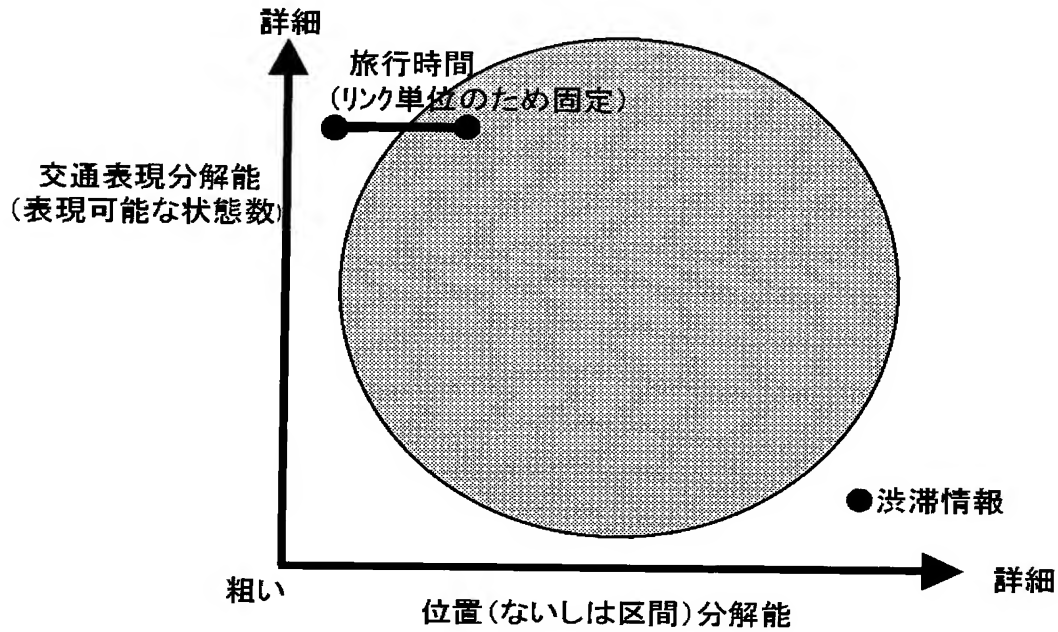
【図４０】


受信側装置（交通情報利用装置）で保有する地図データの道路形状
形状ベクトルの道路形状
基準ノード
基準ノード
基準ノード
対象道路確定後（マップマッチング後）の基準ノード位置

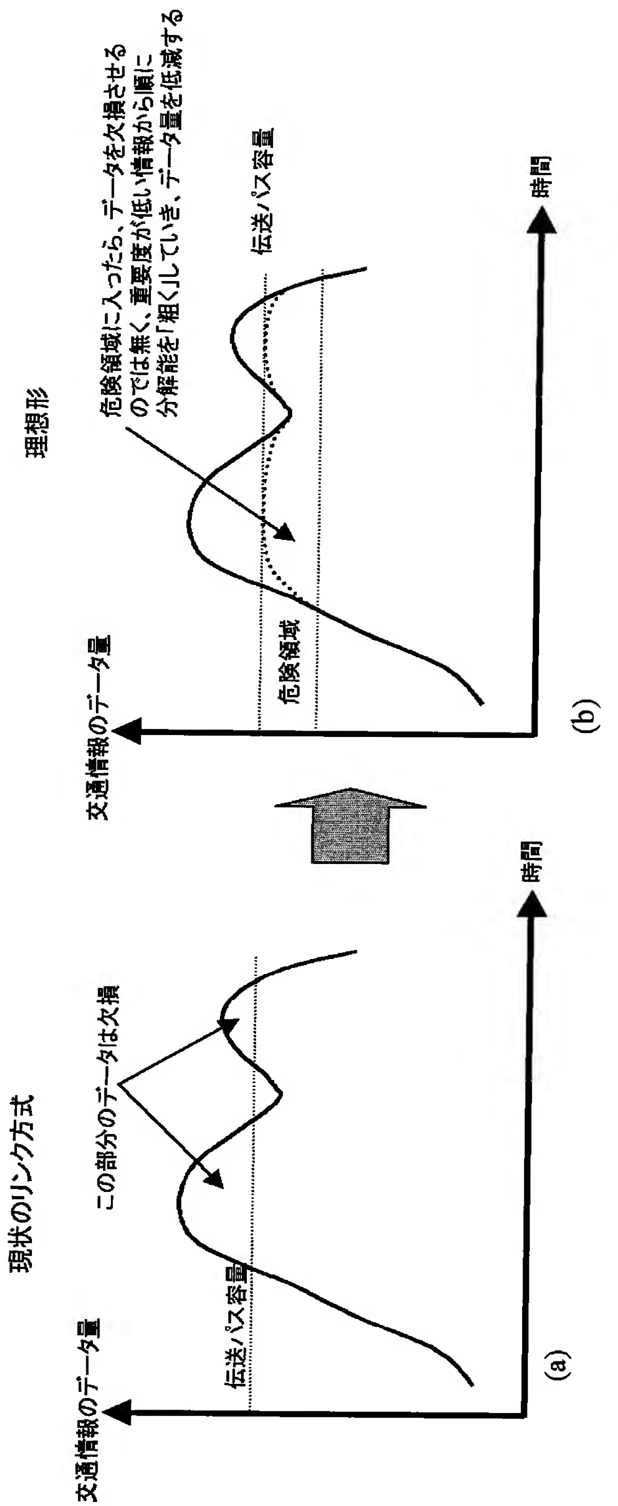
【図４１】


渋滞500m
リンクA
30分
リンクB
23分

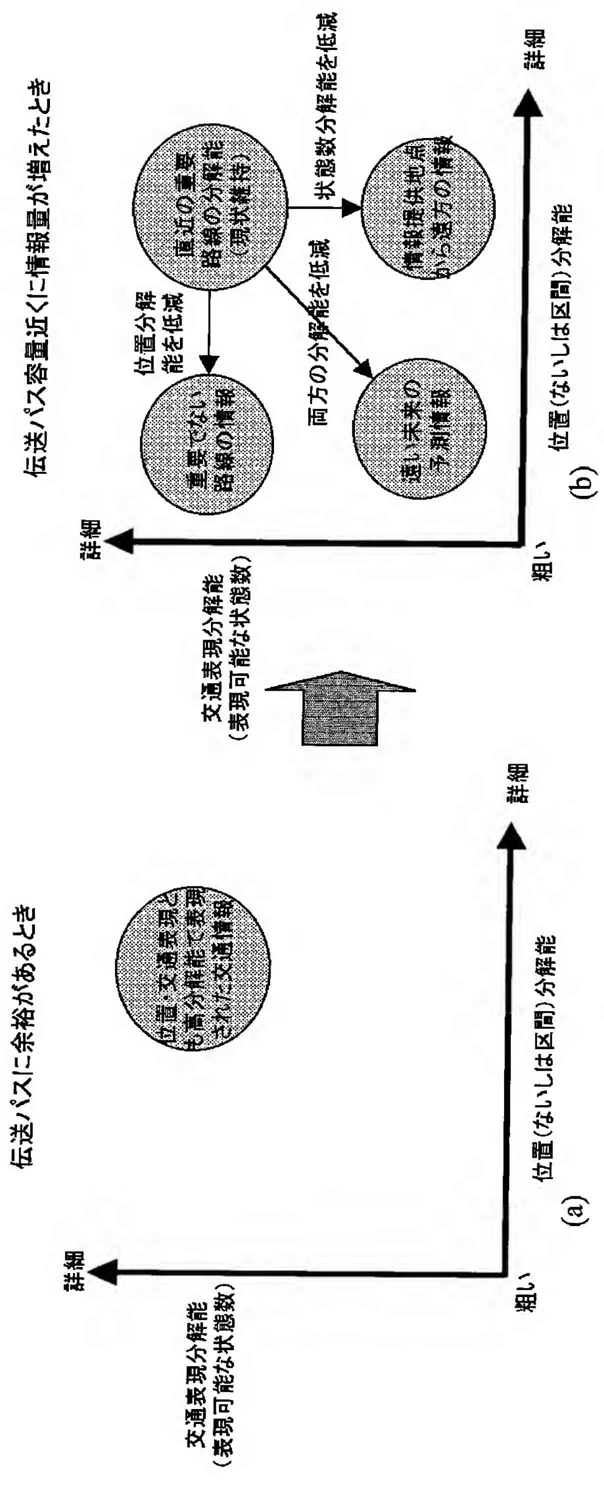
【図４２】


詳細
旅行時間
(リンク単位のため固定)
交通表現分解能
(表現可能な状態数)
●渋滞情報
粗い
詳細
位置(ないしは区間)分解能

【図４３】


現状のリンク方式
交通情報のデータ量
伝送パス容量
この部分のデータは欠損
時間
(a)
理想形
交通情報のデータ量
危険領域
伝送パス容量
危険領域に入ったら、データを欠損させるのでは無く、重要度が低い情報から順に分解能を「粗く」していき、データ量を低減する
時間
(b)

【図４４】


伝送パスに余裕があるとき
位置・交通表現とも高分解能で表現された交通情報
交通表現分解能
（表現可能な状態数）
詳細
粗い
位置（ないしは区間）分解能
詳細
(a)
交通表現分解能
（表現可能な状態数）
伝送パス容量近くに情報量が増えたとき
直近の重要路線の分解能（現状維持）
位置分解能を低減
重要でない路線の情報
両方の分解能を低減
遠い未来の予測情報
状態数分解能を低減
情報提供地点から遠方の情報
詳細
粗い
位置（ないしは区間）分解能
詳細
(b)